During the war and after it is over, let us make mathematics a more effective part of the educational program.—WALTER H. CARNAHAN.

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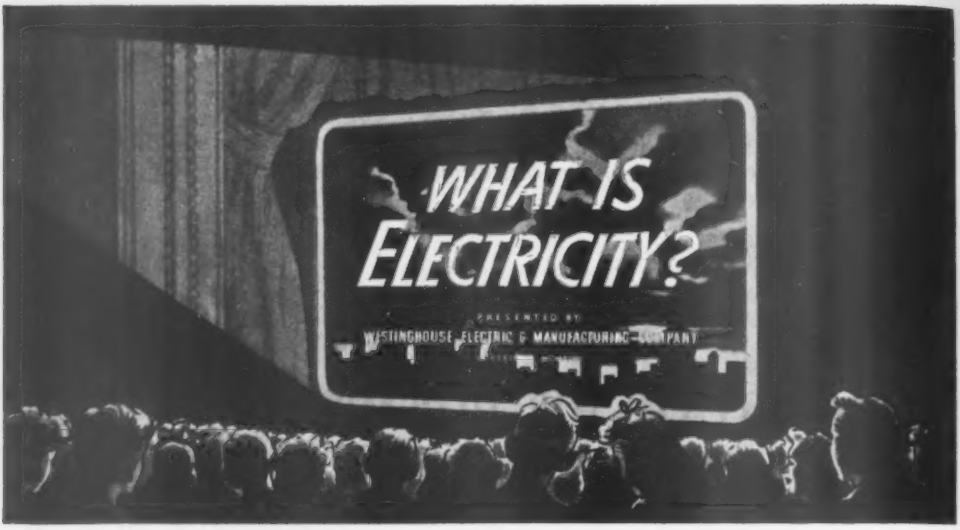

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SCHOOL SCIENCE
AND
MATHEMATICS

VOL. XLIII DECEMBER, 1943 WHOLE NO. 380

MATHEMATICAL SNAPSHOTS*

EDWIN W. SCHREIBER
Department of Mathematics, Western Illinois State Teachers College
Macomb, Illinois

Before my unseen audience has an opportunity to turn the dial to a more interesting broadcast, may I state in the very beginning that mathematical snapshots are fun and the few I have the privilege of presenting at this time are quite entertaining. The characteristics of a good mathematical snapshot are somewhat similar to those of a photographic snapshot. For the latter you must have a pretty or attractive subject, a little light, and a loaded camera. In the case of the mathematical snapshot you should have a subject that arouses a bit of curiosity, again a little light, and a loaded interpreter.

The first mathematical snapshot concerns the *Time Capsule*, deposited on the site of the New York World's Fair on September 23, 1938, by the Westinghouse Electric and Manufacturing Company. The Time Capsule, containing many items of our present civilization, is to remain in the ground, fifty feet below the surface, for 5000 years. In the year A.D. 6939, the people of that era are to raise it, examine its contents, and thus find out how we lived and thought. Without mathematics the exact location of the capsule could not be determined.

The United States Coast and Geodetic Survey fixed the coordinates of the capsule as follows:

Latitude: 40° 44′ 34.089″ North of the Equator.
Longitude: 73° 50′ 43.842″ West of Greenwich.

* Broadcast over Radio Station WTAD, Quincy, Illinois.

These coordinates of latitude and longitude are so accurate that they fix the position of the capsule to within an error of less than two inches north or south, east or west. The thousandth part of a second of arc is less than one-billionth of a circle, the magnitude of which is truly conceived by very few people. Imagine trying to serve 1,000,000,000 guests (half the population of the earth) with only one good-sized apple pie and you have at least a pie-idea of how small one-billionth is.

Our second mathematical shapshot is to deal with large numbers. In these days of war and newspapers, children as well as adults are forced to struggle with bigger and bigger numbers. Millions to the right of us, millions to the left of us, and billions front and rear. Just how big is a million? A smart boy in one of my classes defined it as a 1 chased by six goose eggs! Brilliant, but it still has no meaning. Let us work for a few minutes with a million pennies or $10,000 in copper coins. These million pennies could be brought into any school room in 22 bushel baskets. How long do you think it would take to count and wrap these million pennies, 50 pennies to a roll? Working at the rate of an intelligent bank clerk it would take eight weeks to do the job. You could store these 20,000 rolls of pennies in the bank vault where they would occupy about one cubic yard of space. However be sure the shelves are strong for they will weigh three and one half tons or 7,000 pounds. Do these million pennies help you realize a little better how enormous a million really is? And think of it, a billion is a thousand times as big. Just the other day the national government appropriated $7,000,000,000 for defense. If you would spend $7 every minute, 24 hours a day, not stopping for food or drink or sleep, it would take you more than 19 centuries to spend that $7,000,000,000. Some money, what!

Our third mathematical shapshot is in the field of mathematical recreations and has to deal with the common checker board or chess board—a square board containing 64 smaller squares. The inventor of chess, when asked what he desired for a reward for producing the game, made this rather simple request: "Give me one grain of wheat for the first square, two grains for the second, four grains for the third, eight grains for the fourth and so on for the sixty-four squares." For one who is unfamiliar with the mathematics back of this problem it would seem that the request was a reasonable one. However, when computed, the total number of grains is found to be two to the sixty-fourth power minus one grain, or eighteen quintillion, four

hundred forty-six quadrillion, seven hundred forty-four trillion, seventy-three billion, seven hundred nine million, five hundred fifty-one thousand, six hundred fifteen grains. (18,446,744,073,709,551,615) The number of grains in a cubic inch of wheat is approximately four hundred sixty-eight and this number multiplied by the number of cubic inches in a bushel, which is two thousand one hundred fifty and forty-two hundredths (2,150.42), will give you very nearly one million grains. Assuming then that there are one million grains of wheat to the bushel, the number of bushels of wheat desired by the inventor of chess would be approximately eighteen and one-half trillion. This amount of wheat has never been grown since the time of Christ.

We close with a human interest story concerning a blind mathematician. Nicholas Saunderson, a famous professor of mathematics in the University of Cambridge, and a fellow of the Royal Society of London, was born in England in 1682. When he was but twelve months old, he lost not only his eye-sight but his eyeballs, through small-pox. At an early age, however, being a very intelligent child, he was sent to the free-school at Penniston, and there laid the foundation of the knowledge of the Greek and Latin language, which he improved through his own efforts, so as to be able to hear the works of Euclid, Archimedes, and Diophantus read in their original Greek.

Having acquired an elementary education, his father, who was a tax collector, taught him the common rules of arithmetic. And here it was that his mathematical genius first appeared; for he very soon became able to work the common problems and to make long calculations by the strength of his memory.

At the age of 18, Saunderson became acquainted with Richard West, a lover of mathematics, who, observing his uncommon capacity, took the pains to instruct him in the principles of algebra and geometry, and gave him every encouragement in his power to the prosecution of these studies.

His father, otherwise burdened with a large family, found it difficult to support him, thus his friends began to think of providing both for his education and maintenance. His own inclination led him strongly to Cambridge, and it was at length determined that he should try his fortune there. Accordingly he went to Cambridge, in 1707, being then 25 years of age, and his fame in a short time filled the University. Newton's *Principia*, *Optics*, and *Universal Arithmetic* were the foundations of his

lectures, and afforded him a noble field for displaying his genius; and great numbers came to hear a *blind* man give lectures on optics, discourse on the nature of light and colors, explain the theory of vision, the effect of glasses and the phenomenon of the rainbow.

As he instructed youth in the principles of the Newtonian philosophy, he soon became acquainted with Isaac Newton, and frequently conversed with Newton on the most difficult parts of his works; he also held friendly communication with the other eminent mathematicians of his age, as Halley, Cotes, and Demoivre.

Upon the removal of Mr. Whiston from his professorship, Mr. Saunderson's merit was thought so much superior to that of any other competitor, that an extraordinary step was taken in his favor, to qualify him with a degree, which the statute requires, in consequence he was chosen in 1711, Mr. Whiston's successor in the Lucasian professorship in Mathematics, Sir Isaac Newton interesting himself greatly in his favor. His first performance, after he was seated in the chair, was an inaugural speech made in very elegant Latin, and a style truly Ciceronian; for he was well versed in the writings of Tully, who was his favorite in prose, as Virgil and Horace were in verse. From this time he applied himself closely to the reading of lectures and gave up his whole time to his pupils.

In the year 1728, when King George visited the University, he expressed a desire of seeing so remarkable a person; and accordingly our professor attended the king in the senate and by his favour was there created Doctor of Laws.

Dr. Saunderson had a peculiar method of performing arithmetical calculations, by an ingenious machine and method which has been called his Palpable Arithmetic, and is particularly described in the first volume of his Algebra. That he was able to make long and intricate calculations, both arithmetical and algebraical, is a thing as certain as it is wonderful. He had contrived for his own use, a commodious notation for any large numbers, which he could express on his abacus, or calculating table, and with which he could readily perform any arithmetical operation, by the sense of feeling only, for which reason it was called his Palpable Arithmetic.

His calculating table was a mooth thin board, a little more than a foot square, raised upon a small frame so as to lie hollow; which board was divided into a great number of little squares,

by lines intersecting one another perpendicularly, and parallel to the sides of the table, and the parallel ones only one-tenth of an inch from each other; so that every square inch of the table was thus divided into 100 little squares. At every point of intersection the board was perforated by small holes, capable of receiving a pin; for it was by the help of pins, stuck up to the head through these holes, that he expressed his numbers. He used two sorts of pins, a larger and a smaller sort; at least their heads were different, and might easily be distinguished by feeling. Of these pins he had a large quantity in two boxes, with their points cut off, which always stood ready before him when he calculated. The writer of that account describes particularly the whole process of using the machine and concludes, "He could displace and place his pins with incredible nimbleness and facility, much to the pleasure and surprise of all beholders. He could even break off in the middle of calculation, resume it when he pleased, and could presently know the condition of it, by only drawing his fingers gently over the table."

If among my listeners there are some who are studying high school or college mathematics and are having difficulty in seeing through it, remember the story of Nicholas Saunderson, who, though blind, saw through most of the mathematics of his time.

AZORES, THE TRANSATLANTIC CABLE CROSSROADS

The Portuguese Azores, 800 miles west of the coast of Portugal, is of especial strategical value to the United States because of its location on transatlantic shipping, air and cable routes to Europe and the Mediterranean combat arena.

The nine islands that constitute the Azores lie almost on a direct line from New York to Gibraltar, a little over 2,000 miles from the American port. For many years they have served as a coaling station for boats, and as a refuelling station for transatlantic air liners since the service was inaugurated. They are also the crossroad of Atlantic cables.

Horta, on Fayal Island, is one of the great cable stations of the world, with cables to Ireland, England, Portugal, Cape Verde Islands and America. It is also an air base for Pan-American Airways craft operating between New York and Lisbon.

Ponta Delgada on St. Miguel, the largest city in the Azores, for many years was an important refuelling station, particularly for ships en route to England from South Africa, Australia and the Indian Ocean. It has coal and fuel-oil stations, and also marine repair facilities.

The islands included in the Azores are gathered in three separate groups. Their total area is about 925 square miles. Their population, approximately 255,000 persons, is largely Portuguese. Their economy is principally agricultural. Because of their volcanic origin and nature they were, in prewar days, visited by many tourists.

DAUGHTER OF THE LABORATORY

B. Clifford Hendricks

The University of Nebraska, Lincoln, Nebraska

It was reported as man-made radium. But in the strictest sense it was neither radium nor was it man-made. It, to begin with, was aluminum, not radium, and better say it was induced rather than made. A chief actor in this new never-before achievement was a woman and not a man. However that may have been, it was an eventful day in the world of science as well as in the lives of Madame and Monsieur Joliot when that aluminum continued to emit radium-like rays after taken from the beam of the inducing substance. As soon as that persistent radiation was certified, *induced radio activity* was added to the natural phenomena of the physical world. That was in 1934. From that time the mysterious change called radioactivity, for many years considered beyond the control of man, was reclassified as just another change amenable to puny man's direction.

But present concern is not with radioactivity but the mistress who, with her collaborator, made possible this extension of man's dominion over matter. Her part in the production of this artificial radioactive substance gave further impetus to the idea that the scientific mantle of the distinguished mother, Marie Curie, had fallen upon the shoulders of the daughter, Irene Joliot. Such a succession, in itself, is as newsworthy as the achievement of artificial radioactivity.

From the days of her babyhood, often spent in the companionship of the "blue eyed old man," her paternal grandfather, to the day of induced radioactivity, Irene became increasingly familiar with "the laboratory" a "name endlessly rumbling in her ears." During the first four or five years of her life "Mother was ever away from home, always kept at that laboratory." During that time from that laboratory came news of the isolation and conclusive identification of the much publicized element, radium. Since mother and father both participated in that research, conversation in their home was undoubtedly heavily laboratory-centered. Friends who called were from laboratories. The father, when, at a later time, offered a medal in recognition of his share in his wife's work, exclaimed, "I feel the need of a laboratory more than a decoration."

Mother Curie's contribution to the private school, which she and her friends established for their children, was a laboratory.

In that laboratory she, in person, directed the children's studies. Her older daughter, Irene, was particularly happy and successful under this novel plan of instruction. It was Mother Curie who at a later time said, "I don't know whether I could live without a laboratory."

When World War I absorbed the Curies into its service this older daughter became the laboratory teacher of the nurses who were to become X-ray technicians. And at its end she was at her mother's side, as laboratory assistant, in the school for the American Expeditionary Force doctors who were interested in roentgenology.

Released from war service, wearing a medal of France's recognition of her services, Irene became a student of polonium, the second of the pair of radioactive elements her mother had unveiled before the world of science. Needless to say, that was a laboratory study. For this she was accorded academic recognition. She was pronounced a doctor of philosophy. Hers, however, was a philosophy of natural forces acquired, not from books but from extended observations of those forces in their effects upon matter under laboratory controls.

Academic recognition was a mere incident in the busy time-absorbing work of this lady. Its achievement was no reason for diminished activity in the laboratory which was as much avocation as vocation. News of the progress of that laboratory activity, probing into the unknown of matter's structure, continued to be released with little observable disturbance from commencement processions or degree granting programs.

The laboratory may have its romance as well as its cold objective outcomes. Just as the Curies, father and mother, of this daughter of the laboratory, had "ordered their lives to suit their scientific work" so Irene presently discovered, in a fellow laboratory worker, a "perfect union of ideas, tastes and scientific passion." Thus from the laboratory came companionship and that teamship that was, in a few years, enriching the field of science by papers telling of "New Evidence of the Neutron," more reasons for assuming the existence of a positron and climaxing it all by the Nobel prize winning discovery of induced (artificial) radioactivity.

Romance, realistic romance, requires a home for its nurture. There should be children and twelve year old Helene and ten year old Pierre now satisfy that requirement in the Joliot home. Even so the background of that home is the laboratory. Helene

and Pierre, during their preschool days, soon learned that mother must have time for her laboratory duties. Helene was five and Pierre two when Mother Irene was announced as joint winner with Father Frederic of that year's Nobel prize for chemistry. Thus was repeated the pattern made by Grandmother Marie's reception of that prize when Mother Irene was but three.

Laboratories in modern times have an increasing tendency to become related to activities other than scientific. Business, industry and even governments have, in recent years, been giving more and more attention to the laboratory's needs and achievements. All of this calls for an especial concern upon the part of directors of those laboratories to the relation of the laboratory to the world at large. The connection of Madame Irene Joliot's name with the cabinet of Premier Blum as "Under Secretary for Scientific Research" was undoubtedly an expression of her acknowledgment of this new responsibility of her laboratory to the larger national need. Her acceptance of that office may be considered her further pledge of loyalty to and confidence in the laboratory as the place of scientific research. Thus did the daughter of the laboratory become the mature guardian of its present achievement and the harbinger of its fruitful tomorrow.

NEW TYPE OF VISUAL AIDS CATALOG-DIRECTORY NOW READY

A new and improved type of visual aids catalog-directory titled *Slidefilms and Motion Pictures to Help Instructors*, is announced by The Jam Handy Organization, 2900 East Grand Blvd., Detroit (11) Michigan, and will be sent free on request to any teacher, school, college, or educational group. By a new system of indexing, cross-indexing and classifying, teaching slidefilms and motion pictures covering a wide range of studies, the teacher is enabled to quickly locate any subject needed by the mere flip of the page. In addition, the teacher seeking suitable films to aid in a given study, gets a "preview" of what is available by means of vivid illustrations of sequences reproduced directly from the film itself. In other words, by this arrangement you "see what you get—in advance." Listings are made under the curriculum system, and it has been found that much time and labor is saved for the instructor who otherwise would be called upon to engage in extensive film research work. This catalog-directory is printed in colors, comprising 80 pages of detailed information—including the number of "frames" or pictures in each slidefilm and in each series. One special feature shows what projectors are best suited to various visualized teaching purposes.

HOW HIGH SCHOOL PHYSICS STUDENTS CAN MEASURE THE SPEED OF BULLETS

M. J. W. PHILLIPS

West Allis High School, West Allis, Wisconsin

Ballistics, the science of moving projectiles, is of interest to those teachers of physics who wish to adapt the course to meet wartime needs of pupils. This science gives an opportunity to increase the use of mathematics in high school science as suggested by our government. Measuring the speed of bullets from small arms, rifles and revolvers seems to be beyond the realm of the high school physics student. It really is not as difficult as it

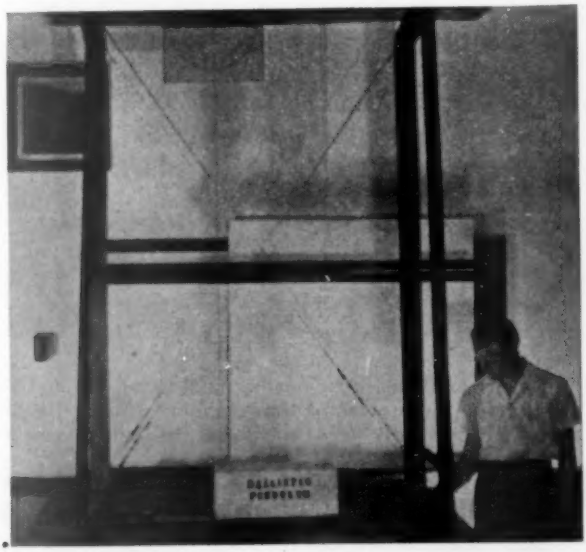

FIG. I. Firing a shot from a revolver into the ballistic pendulum.

appears at first thought. The apparatus is simple and easy to make. An exhaustive treatise of ballistics will be avoided; only its application will be discussed here. Two methods of measuring the speed of bullets will be described, namely, the ballistic pendulum, and two rapidly rotating paper discs.

I. THE BALLISTIC PENDULUM

The ballistic pendulum is the first and the oldest of the methods used to determine the velocity of bullets. It was invented in 1740 by Benjamin Robbins of England. This method gives

fairly accurate results with plenty of mathematical calculation for the interested physics student. The ballistic pendulum for this problem can be made from a piece of timber, eight inches by eight inches and one and one-half feet long which will weigh about twenty pounds. Four screw eyes are fastened near the corners in order that the pendulum may be suspended. On the ceiling of the room or other support, four similar screw eyes are placed in exactly the same position as on the side of the timber. The block is then suspended by eight lengths of silk fish line as is shown in Figure I and Figure II. Care should be taken in suspending the ballistic pendulum to be sure that it is level and that the suspension is so arranged as to reduce sidewise oscillation to a minimum.

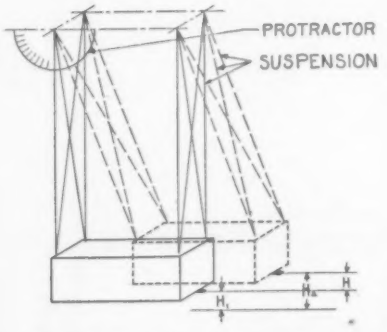

FIG. II. Diagram of the ballistic pendulum showing the method of suspension. Upper left—the protractor. Lower right—the small iron strip to assist in measuring the height "*h*" at the end of the swing of the pendulum.

On the upper left hand suspension, as illustrated in Figure I and II, is mounted a protractor by which one may measure the angle of displacement when the bullet is fired into the suspended timber. This protractor is an inexpensive type made by gluing a paper protractor, fourteen inches in diameter to a piece of plywood. The units of this protractor can be read to fifteen minutes of arc. The paper protractor can be obtained from Eugene Dietzgen, Chicago, Illinois, for about fifty cents. This attached protractor is used only by those who wish to make their calculation on the ballistic pendulum by trigonometry. Better numerical results may be obtained if the section of the protractor that is used is extended, enlarging the arc directly behind the pendulum and then further subdivided with care to give a more detailed angular reading. This extension is not shown in the illustrations.

The principle of the ballistic pendulum is based upon the conservation of momentum. A discussion of this principle can be found in any college physics text. I am of the opinion that an extensive study of the mathematical background is not necessary here as it will serve only to confuse the high school student. The formula for solving the problem for the velocity of the bullet is as follows:

$$V = \frac{M+m}{m}\sqrt{2gh}$$

where V is the velocity of the bullet to be determined
M is the mass or weight of the timber in grams
m is the mass of the bullet in grams
g is the gravitational constant 980 cm. per sec. per sec.
h is the height in centimeters through which the timber is raised vertically by the action of the bullet upon it.

FIG. III. Weighing the ballistic pendulum on a balance to determine "*M*," the large mass.

All that needs to be done, after the timber is suspended, is to weigh it as in Figure III. This weight is referred to as "*M*" or the large mass. A bullet, the velocity of which is to be determined, is removed from the cartridge and carefully weighed. This weight is "*m*," referred to as small "*m*."

When the bullet is fired into the end of the suspended timber, some means must be provided to determine how far to one side

it is pushed by the bullet. Several methods were tried, but a thin silk thread so arranged as to exert very little or no tension on the pendulum was found to be the best. Figure IV explains and shows how this is fastened to the timber and pulled through a slit which may be clamped tight after the bullet has been fired

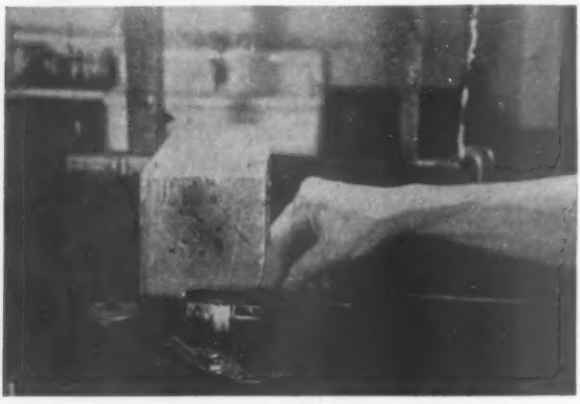

FIG. IV. The silk thread is unwound from the spool during the impact of the bullet and the block. The thread passes through a slit. The thread can be securely clamped in the slit by a thumb nut on a small bolt. This determines how far the pendulum was pushed over by the bullet.

FIG. V. Measuring the height or "*h*" of the pendulum with a micrometer. This is measured to thousandths of a centimeter.

into the timber. This represents the distance the timber was pushed over to one side, and is used in determining the height "*h*." Figure V shows the method of measuring "*h*." This is done by using a metric micrometer which is read to thousandths of a centimeter. A small iron strip is used to help measure the height

of the pendulum at the end of the swing. This strip of iron is screwed on the bottom of the pendulum so that the micrometer can rest upon this strip during each measurement. This is called "h"$_1$ as is shown in Figure II. By stretching the silk thread until taut, you can determine the distance the pendulum was pushed over by the bullet. The pendulum is held in this position by a block and the height is measured with the micrometer. This height is referred to as "h"$_2$. Taking the difference, we obtain "h," the height through which the pendulum was raised by the bullet.

Simply substitute these values in the equation above and the velocity of the bullet can be quickly calculated. If several bullets are fired into the pendulum, the weight of each bullet must be added to determine the new "M" or, in other words, the pendulum must be weighed each time before it is used again. The pendulum gets heavier the longer it is used.

The formula changes slightly for the pupils who desire to use trigonometry. To determine "h," the length of the pendulum is measured from the top of the suspension to the center of the timber; this is the "l" in the formula below. The angle of displacement can be read on the protractor located on any one of the four points of suspension of the pendulum. The formula for the velocity of the bullet then becomes

$$V = \frac{M+m}{m}\sqrt{2gl\ (1-\cos \text{ of angle of displacement})}.$$

This gives opportunity for a more advanced type of mathematics for those pupils and teachers desiring it. Another way always serves as a challenge to the more capable student.

Using a 22 caliber target rifle, a typical problem follows:

M equals 9816.1 grams
m equals 2.5 grams
h equals .058 centimeters

$$\text{Velocity} = \frac{M+m}{m}\sqrt{2gh}$$

$$\text{Velocity} = \frac{9816.1+2.5}{2.5}\sqrt{2\times 980\times .058}$$

Velocity = 41,865.104 centimeters per second.

Divide this number by 30.48 centimeters in one foot to change

to the English system and thus obtain the velocity in feet per second which is 1373.5 feet per second. From Ballistic Tables* the standard value for this type of gun and ammunition is 1375 feet per second.

Target rifles of 22 caliber long or short are readily available from members of your physics classes. Any type of rifle with a velocity at the muzzle of 1500 feet per second or less is best to use. Modern high muzzle velocity sporting rifles may prove dangerous to use in the classroom. The danger of splitting the timber and releasing the bullet is a possibility. Revolvers of all calibers can be used. The muzzle velocities of these range from 700 feet per second to 1030 feet per second.

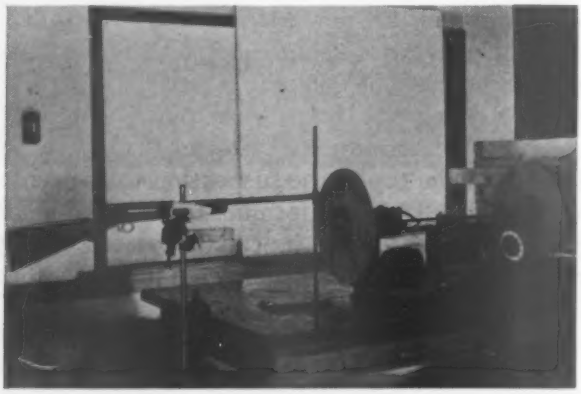

FIG. VI. Apparatus to measure the speed of bullets by rotating discs. Dial on front panel near the disc to the right is an old automobile speedometer, calibrated in R.P.M. so it is used as a tachometer. The box at the right is filled with sand.

II. METHOD OF ROTATING PAPER DISCS

This apparatus was designed by a member of one of the physics classes. He suggested a simpler method of measuring the velocity of a bullet that would not involve so much mathematics. The essential part of his suggestion was to have two paper discs at a fixed distance apart, rotating at a known speed. Well, why not try it? The writer had a variable speed motor fitted with a speed control that had been used on an old type scanning disc television receiver. This boy had a small metal turning lathe in his basement at home. All the parts were made

* *Western Ammunition Handbook*, 4th Edition, pages 50 to 54. Published by the Western Cartridge Company, East Alton, Illinois.

of wood except the metal shaft which was one-half inch in diameter and three and one-half feet long. The discs of paper eighteen inches in diameter, and one sixty-fourth of an inch thick, were mounted on the shaft as shown in Figure VI. An old automobile speedometer from a scrap yard was attached to the shaft by two wood pulleys. The pulleys were used to reduce the speed of the speedometer cable—that is—two revolutions of the shaft to one of the speedometer cable, so the ratio became 2 to 1. This had to be done to keep the indicator hand of the speedometer within range of the scale.

To calibrate the speedometer into revolutions per minute instead of miles per hour, we had to secure a tachometer. Through the courtesy of the Steam Turbine Department of the Allis Chalmers Manufacturing Company, we were loaned a stroboscopic tachometer, known as the "Strobo-Tac" made by the

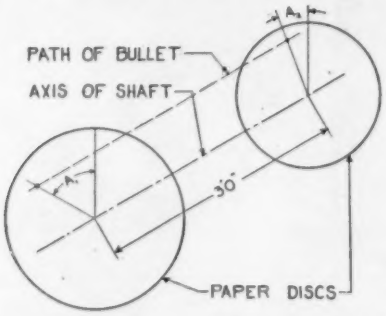

FIG. VII. Schematic diagram showing how the angles are measured to determine the angle with respect to the reference lines. Knowing the speed of the discs, the time of flight of the bullet between the discs is determined by this measurement.

General Radio Corporation. This instrument will measure the speed of a rotating shaft without being attached to it in any way and is exceedingly accurate. The speedometer was calibrated up to 2500 revolutions per minute in steps of 100 revolutions. Thus an old automobile speedometer became a tachometer directly attached to the equipment. The dial of the tachometer is shown near the right hand disc in Figure VI. At the extreme right is a large box of sand to serve as a trap for the bullets fired through the rotating discs. At the left is a 22 caliber target rifle clamped securely so that the barrel is parallel to the shaft carrying the discs. Each disc is divided into quadrants by reference marks, in order that the position of the disc is known when it is pierced by the bullet.

From the diagram, Figure VII, it is evident that as the paper disc nearest the rifle is penetrated by the bullet this hole forms an angle "A"$_1$ with the reference line. After the bullet leaves this disc, the disc to the right has rotated far enough so that angle between this penetration and the reference line is angle "A"$_2$. The difference between these two angles will be the number of degrees the disc at the right has traveled after the bullet has passed through the left disc.

Here is the method by which the speed of the bullet is determined. If the tachometer reading is 1800 revolutions per minute, which is 30 revolutions in one second, each revolution represents 360 degrees: therefore the discs travel through 360 times 30, or 10,800 degrees per second. Assume that the difference between

FIG. VIII. Measuring the angle on the disc with a home-made protractor. The pencil points to the bullet hole. The quadrant line of reference is plainly shown on the disc.

angle "A"$_1$ and angle "A"$_2$ is 24 degrees, then 24 degrees divided by 10,800 degrees or one-four-hundred-fiftieth of a second is the time for the bullet to travel three feet. How far will the bullet travel in one second? It can be seen that the distance would be 3 ft.$\times$450 or 1350 feet per second. This is a simple method of determining the speed of bullets fired from small arms.

The number of problems presented for solution with this type of equipment were many: in fact many more than the writer has ever obtained from any other source. All the problems were quite different. The interest holding character of this work is excellent. The interest was so general in character that the principal of the high school placed it on the Commencement Pro-

gram. This physics lesson with its outgrowth—a project—was given as a demonstration before the members of the graduation class, their parents, and friends. It had a popular appeal at this time.

A NEW BOOK ON THE EYE

A new book on the human eye, notable for a series of 34 remarkable natural color paintings which reproduce in stereographic form the complete serial dissection of the eye and orbit, has just been issued by the Bausch & Lomb Press.

Titled *The Human Eye in Anatomical Transparencies*, the work represents the collaboration of two outstanding authorities on the eye, Peter C. Kronfeld, M.D., and Stephen L. Polyak, M.D. The color paintings are by the able and talented medical illustrator, Gladys McHugh, of the University Clinics, University of Chicago.

A new method of graphic representation, recently introduced, has been employed in the reproduction of the paintings, which have the effect of providing the reader with a translucent, three-dimensional model of the object which can be cleaved at will along any one of a number of planes.

Customary drawings of the separate parts of the eye tend to isolate them from each other and fail to afford an easily grasped idea of the spatial relationship of these parts. The illustrations of Miss McHugh are essentially topographic. Where there was natural stratification, the structures encountered were removed layer by layer in the sequence in which they present themselves to the dissecting knife.

The drawings are reproduced twice the actual size of an adult eye. In the case of the veins and nerves, which appear respectively in blue and yellow, some realism has been sacrificed to diagrammatic representation in order to distinguish them from arteries. The optic nerve, however, is shown in natural color.

Dr. Peter C. Kronfeld, director of education at The Illinois Eye and Ear Infirmary, and associate professor of ophthalmology at Illinois and Northwestern Universities, was prevailed upon to write the text and supervise the work of the artist.

The text has been organized to present not only a systematic account of ocular anatomy, but also a topographic treatment as it presents itself in Miss McHugh's paintings. In the topographic section, some additional illustrations, fully labeled, have been provided for purposes of sure identification.

This modern treatment of the subject by Dr. Kronfeld and Miss McHugh is supplemented by Dr. Polyak's historical section which indicates how far we have progressed in our knowledge of the eye and methods of illustrating it since ancient times.

The process by which the color paintings are reproduced is the first five-color process rotogravure to be produced on an acetate base in which every color involved tone etching. The registry of the various layers is perfect. Essentially, the method reproduces a series of front and back illustrations of sectional parts in register so that the resulting picture becomes a whole object.

Kodachrome reproductions suitable for projection will be available for Balopticons and 2″×2″ slide projectors.

AN APPROXIMATE EUCLIDIAN TRISECTION

Jos. P. Harper
University of Scranton, Scranton, Pennsylvania

The method of "trisection" presented here gives quite accurate results; the maximum intrinsic deviation from a true trisection being not more than $3'$ (from $\frac{1}{3}$ of the total angle) for the central angle.

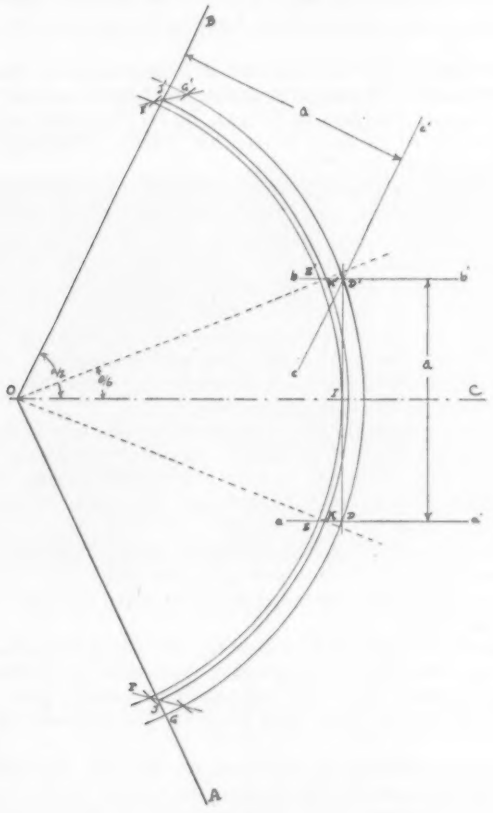

Fig. 1

To carry out the approximate trisection of the angle AOB, or α, Fig. 1, we proceed as follows:

(a) Bisect the angle AOB with the line OC;

(b) Construct the lines aa' and bb' parallel to OC and at a distance of $a/2$ from it ($a/2$ is arbitrary);

(c) Construct the line cc' parallel to OB (or OA) and at a distance of a from it thereby locating D';

(d) Draw an arc through D' with the center at O from OA to OB (across the angle) thereby locating D, then draw in the line DD';

(e) Draw another arc with center at O through the point I of intersection of DD' and OC;

(f) Mark off chords of length a from D and D' so that they cut the outer arc at G and G';

(g) Mark off chords of length a from E and E' so that they cut the inner arc at F and F';

(h) Join the points F and G, and the points F' and G', with straight lines thereby locating the points J and J';

(i) Draw in the arc through the points J and J' thereby locating the points K and K' where this arc intersects the lines aa' and bb';

(j) Join O and K, and O and K', with straight lines. The angles AOK, $\angle KOK'$, and $\angle K'OJ'$ are approximately equal to each other and to $\frac{1}{3}\angle AOB$, and the trisection is thereby accomplished.

It is to be noted that some of the details of the construction are omitted so as to simplify the drawings. Furthermore it should be noted that the constructions by which the points J and J' are located are not both necessary, but this procedure will serve as a check on the drawing.

The error in the "trisection" lies in the fact that the line joining the points F and G (or the points F' and G') is not exactly a straight line since it is the locus of a point at the chord distance a from the line aa' (or bb') on an arc of varying radius. This locus point traces a curve which bends slightly outward (from α) and therefore when the points F and G (or F' and G') are joined by a straight line the point J (and J') is too near O. Consequently $\theta/6$, as shown in Fig. 1, is slightly larger than $\alpha/6$.

To determine the value of θ in terms of α we must first locate the point of intersection of the lines OB and $F'G'$. Referring to Fig. 2, where OC is taken as the x-axis, we see that

$$y_1 = a/2 + a \cos \theta_1$$

and since

$$\cos \theta_1 = 1 - 2 \sin^2 \frac{\theta_1}{2},$$

we have

$$(1) \qquad y_1 = a/2 + a\left(1 - 2\,\frac{a_2}{4R_1^2}\right) = \frac{a}{2}\left(3 - \frac{a^2}{R_1^2}\right),$$

where R_1 is the radius of the outer arc. In the same manner it is found that

$$(2) \qquad y_2 = \frac{a}{2}\left(3 - \frac{a_2}{R_2^2}\right).$$

The values of x_1 and x_2 are then

$$(3) \qquad x_1 = \sqrt{R_1^2 - y_1^2}, \quad \text{and} \quad x_2 = \sqrt{R_2^2 - y_2^2}.$$

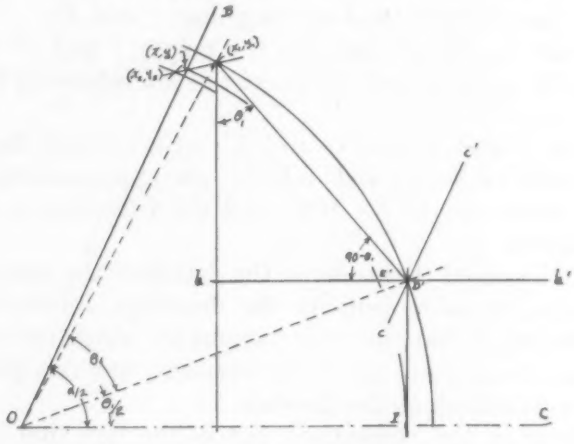

FIG. 2

Now, the slope of the line joining F' and G' is

$$(4) \qquad m = \frac{y_1 - y_2}{x_1 - y_2},$$

and the equation of this line is

$$(5) \qquad y - y_1 = mx - mx_1.$$

The equation of the line OB is

$$(6) \qquad y = x \tan \frac{\alpha}{2}.$$

The coordinates of the point of intersection, J', of these two lines are

$$(7) \qquad x=\frac{y_1-mx_1}{\tan\frac{\alpha}{2}-m}, \quad \text{and} \quad y=\frac{y_1-mx_1}{1-m\cot\frac{\alpha}{2}}.$$

Then the radius of the arc which goes through J and J' is

$$R=\sqrt{x^2+y^2},$$

which reduces to

$$(8) \qquad R=\frac{y_1-mx_1}{\sin\frac{\alpha}{2}-m\cos\frac{\alpha}{2}}.$$

Finally, we have

$$(9) \qquad \sin\frac{\theta}{6}=\frac{a}{2R}=\frac{a\left(\sin\frac{\alpha}{2}-m\cos\frac{\alpha}{2}\right)}{2(y_1-mx_1)}.$$

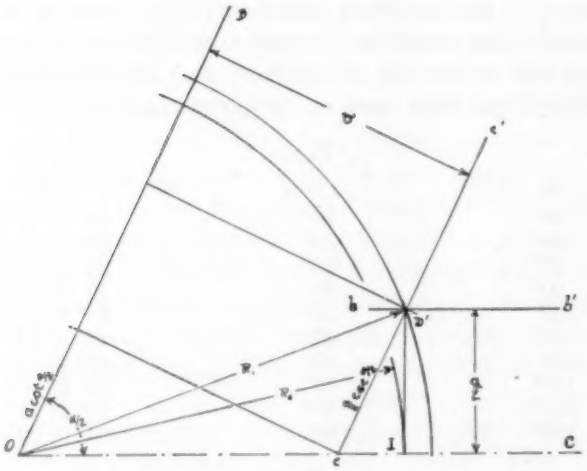

FIG. 3

To determine the values of R_1 and R_2 we refer to Fig. 3, where it it seen that

$$R_1=\sqrt{a^2+\left(a\cot\frac{\alpha}{2}+\frac{a}{2}\csc\frac{\alpha}{2}\right)^2},$$

which reduces to

$$R_1=\frac{a\sqrt{5+4\cos}}{2\sin\frac{\alpha}{2}}. \tag{10}$$

It is also seen that

$$R_2=\sqrt{R_1^2-\frac{a^2}{4}},$$

which in turn reduces to

$$R_2=\frac{a\left(2+\cos\frac{\alpha}{2}\right)}{2\sin}. \tag{11}$$

It is found that equation (9) does not reduce readily to a single explicit function of α. However, by determining the values of R_1 (from equations (10)), R_2 (from equation (11)), x_1 and x_2 (from equations (3)), y_1 (from equation (1)), y_2 (from equation (2)), and m (from equation (4)) a value of θ may be determined from equation (9) and compared to α. A series of values of $\theta/3$ were thus determined and are listed below. Six place logarithms were used in the computations.

TABLE I

α	$\alpha/3$	$\theta/3$
30°	10°	10° 0′ .2″
60°	20°	20° 0′ .7″
75°	25°	25° 0′ 2″
90°	30°	30° 0′ 7.5″
105°	35°	35° 0′ 17.5″
120°	40°	40° 0′ 44″
135°	45°	45° 1′ 24″
150°	50°	50° 2′ 16″
165°	55°	55° 2′ 31″
180°	60°	60° 0′ 00″

ACTIVITIES OF THE JUNIOR RED CROSS

Equipping Army and Navy clubrooms with furniture and small articles made by members in their manual training classes.

Exchanging scrap books with Latin American and European children.

Sending boxes of candy to 10,000 Russian children.

Producing utility bags, bedroom slippers, game sets, and other items for convalescing soldiers.

THE POST-WAR TEACHERS COLLEGE PROGRAM FOR THE TRAINING OF SCIENCE TEACHERS

GERALD OSBORN
Western Michigan College of Education, Kalamazoo, Michigan

This is part of a report presented before Dr. Gray's Teacher College Conference at Chicago on May 4, 1943. Teachers Colleges from Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, and Wisconsin are members of this conference. Since the primary interest of the representatives at this conference was teacher education, this report is devoted to the post-war training of science teachers.

In Michigan according to a report issued in 1934 by the Council of Teacher College Presidents, about 44% of the training of Michigan High School teachers for the year 1931–1932 was obtained in the four teachers colleges; 71% of the training of our elementary teachers was obtained in the same colleges. In the year 1939–1940 the state of Michigan[1] certified 1361 high school teachers, of which number 589 or 43% were trained in Michigan teachers colleges. If poor science teaching is found in Michigan high schools, the teachers colleges must assume responsibility for such a condition since they are the largest single agent in the production of teachers. In 1932 Professor S. R. Powers[2] was inclined to place much of the responsibility for poor preparation of science teachers at the feet of the teachers colleges. He especially pointed to the poor quality of teacher college science faculties. He made an analysis of the training of the science faculties in the teachers colleges of certain states and found that only 25% had attained the doctorate degree, while in the state universities and recognized colleges of the same states 62% of the science faculties had the doctorate degree. The states selected for this study included Arizona, Colorado, Ohio, Pennsylvania, Maryland, and New Jersey. A more recent report[3] states, "The teachers colleges are becoming better staffed and more critical in their standards. . . . But, with all these improvements the beginning teacher of science or mathematics is seldom adequately prepared for the kind of teaching he must actually do."

[1] Michigan State Department Report, Unpublished.

[2] "A Program for Teaching Science," *Thirty-first Year-Book of the National Society for the Study of Education*, pp. 325–344, 1932

[3] Cooperative Committee on Science Teaching, "The Preparation of High School Science Teachers," SCHOOL SCIENCE AND MATHEMATICS, 42, pp. 636–650, October 1942.

I think that we will all agree that teachers colleges, in order to prepare good teachers of science, must meet the following requirements:

1. An adequately trained faculty.
2. Adequate space in the form of well-planned lecture rooms and well-equipped laboratories.
3. Careful selection of candidates for such training.
4. Well organized curriculum for the training of science teachers.

To be sure, other requirements could be added such as adequate placement facilities, suitable system of follow-up (in-service training), etc. Let us apply the above criteria to thirteen of the fifteen teachers colleges represented at this conference.

As a result of a questionnaire sent to the participating colleges, the data given in the table were obtained. Two of the fifteen colleges failed to answer the questionnaire.

PRESENT STATUS OF SCIENCE FACULTIES IN THIRTEEN MIDWESTERN TEACHERS COLLEGES AS OF JULY 1, 1942

School	*Tot. Sci. Fac.*	*No. in Tr. Sch.*	*No. of Ph.D. Teach.*		*Members on Leave*	
			Sci. Spec.	*Ed. Spec.*	*Military*	*Other*
1.	21	1	12	1	3	4
2.	15	2	12	0	1	0
3.	7	0	3	0	0	0
4.	12	0	7	0	1	0
5.	24	3	11	0	1	1
6.	9	1	6	0	1	0
7.	11	3	8	0	0	1
8.	10	0	7	0	0	0
9.	22	1	9	0	3	1
10.	—	—	—	—	—	—
11.	4	0	3	0	0	3?
12.	5	1	2	0	1	0
13.	6	0	4	0	2	0
14.	—	—	—	—	—	—
15.	10	1	5	1	0	0
Total	156	13	89	2	13	10
Percent Ph.D.	58.3%					

There are a total of 156 teachers of science on these faculties and 91 or 58.3% hold the Ph.D. degree. Two of these specialized

in education; all the rest have specialized in some field of science. In the main, I would say that the college presidents of these thirteen teachers colleges have science faculties far superior to the ones described by Dr. Powers in 1932. True, the doctorate degree is not necessarily the criterion of a good teacher. We can all cite illustrations to prove this point. However, it does indicate that the science faculties are well grounded in their subject matter.

Let us now consider the second criterion, namely, the matter of adequate space. Some states have done better in this respect than others. I envy science teachers in some of the teachers colleges in Illinois. Normal University at Normal, Illinois has a recently built science building which seemed most adequate to me when I visited it two summers ago. I understand that there have been provided excellent modern science buildings at Charleston, Carbondale, and DeKalb. The school at Macomb does not seem to have fared so well. The four teachers colleges of Michigan have not fared so well either. I am sure that the presidents of these schools would agree that the science departments of all four schools are inadequately housed. The past twenty years have seen these four schools go from two-year normal schools to four-year teachers colleges and in every case the science classes are still housed in the same old cramped quarters. The Michigan State Normal College at Ypsilanti is in the process of building an annex. In one of our Michigan cities are located a private liberal arts college and a state teachers college. The liberal arts college had in 1940 an enrollment of 400 students and the teachers college had an enrollment of over 2600. The liberal arts college had devoted to chemistry, in a building built in 1927, 18,000 square feet; the teachers college had a total of little over 5000 square feet. To be sure, a larger percentage of the students of the liberal arts college were taking chemistry; that year, 200 students were in the chemistry department of the liberal arts college while the teachers college had a little over 400 students enrolled in chemistry. The above is not an isolated case. Why do I make so much of this point? For this reason: after the war is over, beyond a doubt, enrollment in teachers colleges will take a big jump. The impetus given to the study of physics, geography, and other phases of science will greatly strain the present science building facilities of some of the teachers colleges of this region.

Going now to the third criterion, recently Dr. Ralph W. Tyler[4]

[4] Tyler, Ralph W. "Trends in the Preparation of Teachers," *The School Review*, 51, pp. 207–212, April 1943.

of the University of Chicago called attention to the need of better selection of teacher candidates. Too often students enter the teachers colleges to take pre-professional work and later when they find that they have done too poor a grade of work for admission to a professional school, they stay on in the teachers colleges and in some cases are permitted to prepare to teach science. They are not suitable material for the medical profession or for the law, and *yet they become teachers of our boys and girls*. It would seem that not later than the beginning of the junior year, some selective system should weed out all undesirable candidates for the teacher training courses. Not having done work in this field, I hesitate to suggest any mechanism for the purpose. However, it would seem that such a system must take into account the complete individual; scholarship alone should not be the hurdle. The medical profession makes use of personal interviews, aptitude tests, and recommendations of previous teachers of the candidate.

We now come to a very important part of our report, the curriculum. The present program for the training of high school science teachers too often follows one of the following undesirable plans:[3]

1. A student takes a smattering of courses in the various fields of science and never gets beyond one year of work in any of the fields.
2. A student becomes interested in one science field and is permitted to pyramid in that field to the exclusion of other fields of science.

The departmental system is probably the main contributing factor to the second undesirable plan. An over-zealous departmental head of chemistry, for example, permits a student to take 40 semester hours of chemistry without taking any work in biology or the earth sciences. When this student first goes out to teach, he will probably have to teach in a small high school, acting as instructor for all of the science courses, along with some courses in mathematics. Since this is true, the teachers colleges should give the student a program which will train him to be a high school science teacher rather than a program for special subject fields such as biology, chemistry, or physics. For this purpose some plan of divisional organization within the teachers colleges is needed. Questionnaire answers indicate that

some of the 15 teachers colleges of the conference are so organized. Do not let me be misunderstood; I feel that, in the larger colleges, departments are necessary, but over the departments there should be a divisional director or divisional committee. The idea here expressed is *not* that we should become universities with separate schools.

After having carefully considered the recommendations of the Cooperative Committee of Science Teaching,[3] various reports of the National Committee on Science Teaching,[5] and a study developed at Syracuse University,[6] the following conclusions can be drawn:

1. An adequate curriculum for the training of science teachers must meet at the same time the need for depth and breadth of training.
2. The semester hours devoted to science courses must total between 52 and 60.
3. The science teacher must have taken additional courses in fields of social sciences and the humanities and arts, along with required work in education.

The report of one of the sub-committees of the National Committee[5] would require 12 semester hours of functional social studies, 12 semester hours of functional arts and humanities, and 24 semester hours of education, methods work and directed teaching. This report justifies this requirement by further stating that the well-trained science teacher

(a) should take an active part in community life,
(b) should appreciate the evolutionary nature of American democracy and not accept without question a mode of living just because it exists today,
(c) should learn the scientific method by practicing it. He should examine what people actually do when engaged in scientific research. He must learn to find problems in situations and find ways of solving them. For example, if the high school teacher be employed in an agricultural

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[5] National Committee on Science Teaching
(a) "Science Teaching for Better Living"
(b) "Redirecting Science Teaching in the Light of Personal-Social Needs"
(c) "The Education of the Science Teacher"
Pamphlet reports sponsored by the American Council of Science Teachers, N.E.A. 1942.

[6] American Council on Education, "A Fundamental Program of Teacher Education," pp. 160–182. Published by the American Council on Education in 1941.

region of Kansas where soil erosion is a problem, he should take an active part in helping the community to solve the problem. Furthermore, he should be trained to cope with controversial issues such as racial prejudice, sex education, and evolution.

Let us now consider just what use should be made of the 52 to 60 semester hours in science. At least four fields of science must be considered:

1. Biological sciences
2. Chemistry
3. Physics
4. Earth Sciences

The following requirements would be in keeping with the more recent reports mentioned above:

1. One major of 20–24 semester hours in one of the above fields.
2. Two minors of 12–16 semester hours each from two of the other fields.
3. In addition, certain requirements in mathematics should be made depending upon the high school background and also upon the major field selected.
4. Professional orientation and philosophy of science teaching, 4–6 semester hours. This requirement would be a part of the 24 semester hours required in education. Practice in organizing science subject matter fields along the line of functional areas would be stressed. Such functional areas as the human life span, conservation, maintenance of personal and public health, and the nature of the earth and the universe are good examples.

The above program for post-war training of science teachers would not offer too much opportunity for free electives. However, within the various fields of requirement there would be opportunity for choice.

The matter of the post-war science program of teachers colleges in its relationship to the training of elementary teachers should be given consideration. The present writer is not an authority in this field. Recent articles, the present questionnaire study, and conferences with experts in this field seem to indicate:

1. Too little has been done in this field.
2. Since departmental teaching is not encouraged in the elementary field, each elementary teacher should have some very definite experience in science work.
3. The subject content[7,8] of science for the elementary school should be a broad program of elementary science rather than nothing but nature study.

If the above statements are true, it would seem that broad survey courses in the physical sciences and in the biological sciences accompanied with some selected laboratory work would be the desired courses that should be required of all elementary teachers. One of the colleges of this conference reported as a recent change in the training of elementary teachers, the minimum requirement of four quarter hours from each major field of science.

Two of the colleges of this conference reported that for the elementary teacher they were placing much greater stress on the contributions of science to agriculture and to health.

As scientific problems of the present war have arisen, the scientists have met them. I refer to the large-scale production of synthetic rubber, magnesium, 100-octane aviation gasoline, and similar achievements. Likewise, I am confident that the teachers within the science departments of the teachers colleges will be able to solve the many problems of the post-war period as they arise.

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[7] Curtis, F. D. "The Teachers of Science in Grades 1 through 6," *Review of Educational Research*, 12, pp. 369–374, October 1942.

[8] Robertson, M. L. "The Emerging Curricula in Elementary Science," *Science Education*, 26, pp. 178–186, December 1942.

THIRD SEARCH STARTS

The third annual Science Talent Search is now under way in the nation's high schools. This month 40,000 high school science teachers will be asked by Science Clubs of America, which conducts the search under the sponsorship of Science Service, to aid in the selection of the 40 most scientifically talented seniors of the class of '44. The forty boys and girls finally selected, on the basis of an essay (on the subject "My Scientific Project"), a stiff aptitude test and comparisons of school records, will be brought to Washington for an all-expense trip to the five-day Science Talent Institute next February. There they will undergo further stiff examinations and interviews, and will be awarded Westinghouse Science Scholarships ranging in value from $100 to $2400.

MAGNETIZING AND DEMAGNETIZING WITH ALTERNATING CURRENTS

WALTER A. THURBER
State Teachers College, Cortland, New York

In almost every science laboratory there are magnets which have lost much of their effectiveness. These can be restored rapidly by means of the apparatus described below. In addition, the apparatus has other important uses.

A cardboard mailing tube about ten inches long is wound with a layer of #24 enameled magnet wire, about 500 turns being required. A coat of shellac aids in firming the coil. The coil is connected in series with a 1000-watt heating element and a source of 110-volt alternating current. Any resistor which limits the current to that carried by the line fuses may be used.

A piece of steel is magnetized in the coil by turning the current on and off quickly. Suitable results are not always obtained at the first attempt, the magnetism being sometimes weak and, in the case of old bar magnets, sometimes reversed. However, the objects may be replaced in the coil and satisfactory results may be expected on the second or third attempt. The magnetism produced by this treatment is a matter of chance rather than one of cumulative effects, as will be discussed later. Therefore, the current need be left on for the briefest possible moment and overheating of the coil may be avoided.

In restoring old magnets the writer standardizes them against a good magnet by bringing each in turn near a compass and noting the deflection. Any magnet which does not exhibit proper polarity and suitable strength is remagnetized until it does.

Darning needles, knitting needles and other objects magnetized by students in laboratory periods may be demagnetized with the same apparatus, the only change in procedure being that the objects are slowly withdrawn from the coil before the current is turned off. The writer demagnetizes several packages of needles at one time.

The process of magnetizing and demagnetizing makes an interesting classroom demonstration. A bar magnet is shown to affect markedly a demonstration compass. The bar is then thrust into and is withdrawn from the energized coil. Almost magically the bar has lost its ability to affect the compass more than any bit of iron can affect it. It can be remagnitized by

turning off the current while the bar remains in the coil. Pupils may not be able to develop a correct explanation independently, but with a little help they quickly see the major implications.

The intensity and direction of the magnetism in a bar treated as above depends upon the portion of the current cycle attained

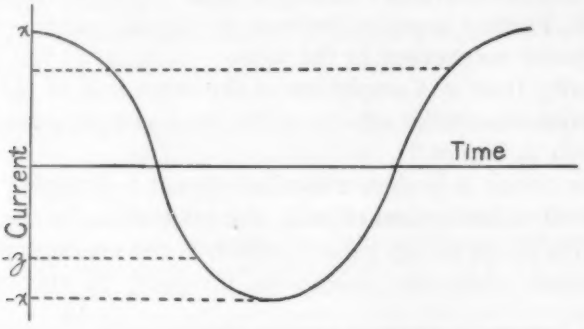


FIG. 1. A typical alternating current wave.

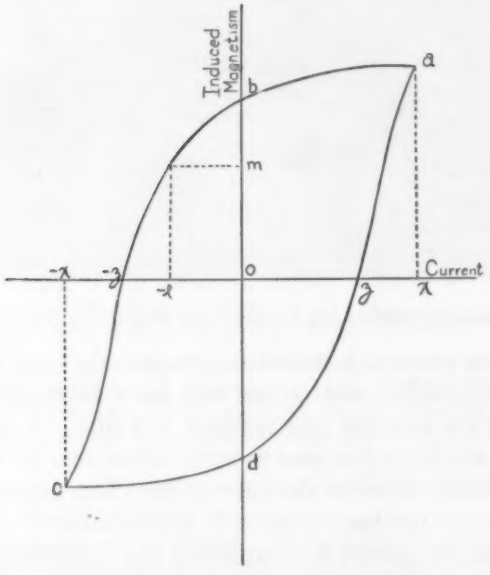
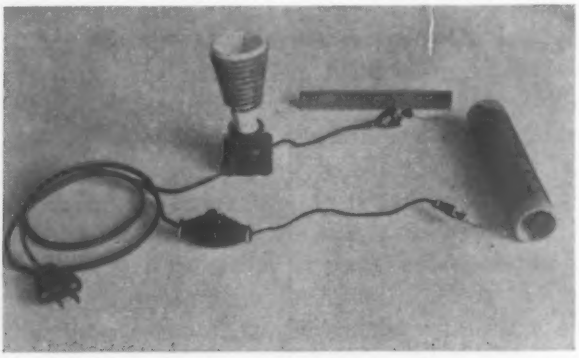


FIG. 2. A curve showing the theoretical relationship between an alternating current and the magnetism induced in a bar of steel by the current.

by the current at the instant the circuit is broken. Assuming that the current follows the typical curve shown in Figure 1, at the time of maximum current x the induced magnetism will

have a maximum value a as shown in Figure 2. As the current drops to zero, the induced magnetism drops, not to zero, but to a value b, which represents the tendency of that piece of steel to retain its magnetic properties (residual magnetism). The electricity must reverse and do work in order to destroy this residual magnetism, the current reaching a value $-z$ before accomplishing this. Further negative increase to the maximum $-x$ brings the induced magnetism to the value $-c$, equal to but reversed in polarity from a. Completion of the other half of the current cycle produces similar effects on the steel as represented by the curve cda in Figure 2.

If the circuit is broken while the current is dropping from its maximum value x, toward zero, the magnetism in the bar immediately drops to the value b, which is the maximum residual magnetism under the conditions involved. If the circuit is



The apparatus needed for magnetizing and demagnetizing steel.

broken as the current is increasing negatively from zero to $-z$, part of the residual magnetism will have been destroyed, for instance, if the current has reached a value -1, the residual magnetism will have dropped to some value near m. In theory, a break in the circuit when the current has risen negatively to the value $-z$ leaves the bar completely demagnetized.

A break as the circuit is completing the remainder of the first half of the cycle leaves the bar with a residual magnetism somewhat less than the induced magnetism at the moment of the break, d representing the maximum value of residual magnetism attained when the current has reached its maximum $-x$. Breaks during the second half of this cycle produce effects that may be predicted by the continued analysis of Figure 2.

To appreciate the demagnetizing effect of withdrawing a bar from the energized coil one must consider that the abscissa of Figure 2 represents the magnetizing effect of the current rather than the current itself. As the bar is removed from the coil this magnetizing effect becomes increasingly smaller. The entire curve *abcda*, therefore, repeated sixty times a second, becomes smaller and smaller until for all practical purposes each of the values becomes zero.

PHOSPHORS BRIGHTEN THE OUTLOOK FOR POST-WAR RADIO-ELECTRONIC ERA

H. W. Leverenz

Development of new and highly efficient luminescent materials holds great promise of opening new fields of activity in the post-war era.

The war has tremendously accelerated research in the field of phosphors, which are tiny crystals that convert invisible radiations to visible light. Thousands of phosphors synthesized prior to the war had unusual properties, but low efficiencies. Today many uses have been found for these phosphors although they were previously ignored in the search for greater brilliancies. When blackout conditions were imposed, the despised phosphors received careful reconsideration by research men because the dark-adapted eye is some 200,000 times as sensitive as it is in daylight vision.

The electrical energy applied to phosphor crystals creates light by changing the atomic structure of the crystals. When a swift cathode ray or quantum of ultra-violet strikes a phosphor crystal, one of the "bombed" atoms in the crystal is stripped of its least tenacious electron. This electron wanders through the crystal until it is trapped in one of the few imperfections. Some time later, latent heat energy again liberates the electron so that it can once more wander about until it chances too near its own "home" or another vacant site. On close approach, the electron dives into the parent haven, which acknowledges its arrival by a momentary scintillation of light. This simple act multiplied by "skintillions" emits light useful for commercial and scientific purposes.

Phosphors are unique in being able to do the following:

Instantaneously transform invisible radiations, such as cathode rays (swiftly-moving electrons) or ultraviolet, into visible light.

Store light, or 'remember' information, for controllable time intervals lasting from less than a hundred-thousandth of a second to more than a day.

Convert electric power into white or colored light more efficiently than any other known practical means.

Some of the properties of phosphors have ranges which are astronomical in magnitude. For example, a phosphor may be made to glow for several minutes after a fleeting excitation lasting less than one-millionth of a second. The same phosphor will produce visible light under impingement of electrons accelerated by as little as six volts or as much as six million volts. Furthermore, some phosphors are so sensitive that electron beam currents smaller than one-hundred-millionth of an ampere suffice to excite discernible luminescence, whereas the same materials, in coatings as thin as tissue paper, can withstand high voltage electron bombardment of intensity adequate to crack an underlying Pyrex glass disc.—*Radio Age.*

MODEL MAKING FOR BIOLOGY

ELIZABETH GRAY
Forest Hills High School, Forest Hills, New York

One of the pleasures of making biological models, as far as the teacher is concerned, is the enthusiasm displayed by the students. As they participate, there seems to be a decided and continuous interest in the work they are doing. It is probably so because they can see a definite accomplishment from lesson to lesson as they produce a model or exhibit. However, there are more tangible values accruing from their activity as all of the materials made by the boys and girls may be used as teaching devices in the biology classroom.

The objective material made is large, clearly visible from all parts of the room and inexpensive. The materials used can be obtained at very little cost. These are things like papier mâché, paper towels, flour paste, plaster, wax and paint. The only two more costly materials are balsa wood and the new liquid latex. Actually, hundreds of dollars have been saved in the schools where models have been produced.

Many of the models which can be made are not listed in any biological catalogue put out by the supply houses. Therefore, if one wishes to have them, there is no alternative but to make them or have them made.

The techniques involved are unbelievably simple and can be carried out by any average group of students. The large collection of models in one of our city high schools has been practically all student made. The students worked in a club under the supervision of a laboratory assistant who taught the procedures while they carried them out.

Since organizing the students in the form of a club for this work has proved most practical, an outline, divided into fifteen club sessions, is presented in the following pages. A club actually meets more than fifteen times in a term. However, it has been found that, here and there throughout the term, work lags due to absenteeism, etc., and so an extra session is needed occasionally to bring it up to date. Therefore in practice, there would be more than fifteen sessions.

Sessions 1 through 6 cover the technique of making permanent, inexpensive models from plastocene, flour paste, and paper towelling. These models are delightful when they are finished in that they are very realistic, large and colorful. They are ex-

tremely durable and very light in weight. The finished product is really nothing but paper towelling hardened in flour paste and covered with a coat of paint.

SESSION I

AIM—To make a large model in plastocene (modelling clay) of an object studied in Biology. (The plastocene is only a pattern for the permanent model.) The model should be at least 12 or 18 inches long, namely, large enough to be seen in the rear of the average classroom when held in front of the room.

POSSIBILITIES FOR MODELS

1. Elodea Cell
2. Ameba
3. Onion Tissue
4. Diplodocus
5. Triceratops
6. Duckbill Dinosaur
7. Yeast Budding
8. Typical Animal Cell
9. Mold Conjugation—Stage 1
10. Mold Conjugation—Stage 2
11. Mold Conjugation—Stage 3
12. Mold Conjugation—Stage 4
13. Paramecium
14. Conjugation in Spirogyra—Stage 1
15. Conjugation in Spirogyra—Stage 2
16. Conjugation in Spirogyra—Stage 3
17. Mitosis (Six models)
18. Chromosome Abnormalities
19. Plasmolized Cell (onion)

MATERIALS

1. A plyboard (2 ft. $\times 1\frac{1}{2}$ ft.) for each individual on which to place the model
2. Plastocene
3. Individual modelling tools
4. Paper towels and soap for hands
5. Hammers or mallets for pounding clay
6. Textbook drawings for reference

PROCEDURE

Give each student one of the boards and have him pound his large mass of modelling clay with a mallet to soften it. Then, with the modelling tool, the clay should be formed into the desired object. The student should refer to a drawing or textbook for details. The average student has a tendency to make the object flat and too small. Therefore, stress large size and the three-dimensional idea.

ASSIGNMENT

Bring a pan (about 8 in. diam.) knife, spoon, smock and a supply of newspapers.

SESSION II

AIM—To cover the plastocene pattern made in Session I with strips of paper towelling.

MATERIALS

1. Pans (brought by students)
2. Paper towelling (cut in strips—$\frac{3}{4}$ of an inch wide & 12 inches long)
3. Scissors
4. Flour
5. Spoons
6. Knives
7. Plenty of newspapers to protect the furniture

PROCEDURE

Equal quantities of flour and water should be mixed in the pans (a cup of water to a cup of flour). The strips of paper towelling should be dipped in this paste and applied in overlapping layers directly on the plastocene pattern until it is entirely covered. Only 3 or 4 layers can be applied during one session as these layers must dry thoroughly before the next ones are put on.

SESSION III

AIM—To finish the application of the paper towelling.

MATERIALS

Same as in Session II.

PROCEDURE

Continue applying layers of paper strips until about eight layers, in all, are on and then allow to dry until the next meeting.

SESSION IV

AIM—To remove the plastocene pattern from the model.

MATERIALS

Same as in Sessions II and III with the addition of heavy cardboard and cord.

PROCEDURE

Assume that a model of a dinosaur has been completed. The student takes a knife and cuts through the animal crossways. Then all plastocene must be removed from each half. The two halves are matched together again and secured in place by means of 3 layers of towelling strips dipped in paste. If the model is box-like, as in the case of the onion cell, the plastocene can be removed from the back. Then cut a piece of cardboard to fit and fasten it to the back by the usual method (strips dipped in paste). Save all plastocene. It can be used over and over.

SESSION V

AIM—To prepare the objects for painting.

MATERIALS

1. Sandpaper
2. Shellac
3. Brushes (10¢ variety)

PROCEDURE

Sandpaper the models until they are smooth and no traces of the individual paper strips can be seen. Apply a heavy coat of shellac. Set aside to dry.

SESSION VI

AIM—To paint the models in suitable colors to emphasize important parts.

MATERIALS

1. Enamels (various colors, 10¢ variety)
2. Paint brushes
3. Turpentine
4. Newspapers
5. Paint stirrers (& rags)
6. Jar to hold brushes

PROCEDURE

Paint, as far as possible, in realistic colors. For example, an Elodea cell could have pale gray cytoplasm, darker gray for cell wall and green chloroplasts, etc.

SESSION VII

Sessions 7, 8 and 9 cover the making of large, bas-relief models to be hung on the classroom wall (size 3 ft. $\times$2 ft.). These contribute much to make the average classroom more colorful and interesting.

AIM—To outline one of the following possibilities in pencil on a large piece of wallboard and to build a wire foundation on this outline.

POSSIBILITIES FOR MODELS

1. Conjugation in Mold
2. Conjugation in Spirogyra
3. Spore Formation in Mold
4. Reproduction in the Flower
5. A Villus
6. Abnormalities in Chromosomes
7. Tissues (bone, muscle, nerve, cartilage, epith., etc.)
8. Maturation
9. Possible Chromosome Combinations in Maturation

MATERIALS

1. Several braces and a supply of bits or drills
2. Wire
3. Wallboards (each 3$\times$2 ft.)
4. Pliers to cut wire
5. Textbooks

PROCEDURE

Each student is to take a large wallboard and is to make a large outline drawing, in pencil, of the object he desires to make on it. Textbooks should be used for reference.

Then brace and bit are to be used to drill holes following the outline. The holes should be about 3 inches apart. Copper, or other wire, is laced through these holes in hit or miss fashion keeping inside the outline. Do not pull the wire too tight. The finger should be able to slip between the wire and the wallboard. The wire may be fastened by twisting on the reverse side whenever necessary.

SESSION VIII

AIM—To apply papier mâché to the boards which were prepared in the previous session.

MATERIALS

1. Papier mâché (previously prepared except for flour)
   How to Prepare Papier Mâché
   A. Tear newspapers into tiny bits
   B. Place the paper in a large jar or bucket
   C. Cover with water and allow to stand 3–4 days
   D. Drain off surplus water and work over the mixture until it is like dough
   E. Add one part of flour to two parts of mashed paper and mix
2. Flour
3. Pans to hold the mix

PROCEDURE

The flour should be mixed with the paper pulp, which has been prepared before the group meets. When the flour and paper pulp are blended, the mass resembles putty. Begin to apply this to the wall board in a raised design following the drawing. Be sure to press it under the wire loops but at the same time covering all loops thoroughly. Work the putty-like design with the fingers until it is very smooth. Set aside to dry. By the following week, the raised design on the wall board will have become very hard and ready to paint.

SESSION IX

AIM—To paint the bas-relief models in suitable colors to emphasize important parts.

MATERIALS

(See previous painting lesson—Session VI.)

SESSION X

AIM—To model some one of the following possibilities in plastocene so that a plaster cast may be made from it. These are designed so that the finished models resemble large plaques.

POSSIBILITIES FOR PLASTER OF PARIS MODELS

1. Mitosis Set (6 models)
2. A Gland
3. Germination of a Seed
4. Onion Cell
5. Fat Cell
6. Epithelial Cell
7. Blood Cell
8. Villus
9. Heart
10. Paramecium
11. Euglena
12. Stentor
13. Vorticella
14. Trachea, Bronchi and Lungs
15. Reflex Arc
16. Elodea
17. Andalusian Fowl
18. Ameba
19. Four O'Clocks
20. Crossing-over of Chromosomes

MATERIALS

1. Boards to hold models
2. Plastocene
3. Individual modelling tools
4. Textbook

PROCEDURE

Make a model in plastocene but remember that any part that appears raised in the finished model must be hollowed out in the plastocene pattern.

For example, to make a model of one of the stages of mitosis, take a mass of plastocene and flatten it out into a layer, 1½ inches thick, on the board. With a modelling tool, scoop out the chromosomes, asters and astral rays. Build a circular wall of plastocene, about 1½ inches high, at what is to be the outer edge of the cell. Plaster is to be poured inside this wall next session.

SESSION XI

AIM—To cast the model made in the previous session in plaster.

MATERIALS

1. Pans
2. Plaster of Paris
3. Spoons
4. Newspapers to protect furniture

PROCEDURE

Take the model which was made at the last meeting. A sufficient amount of water to fill the depression, formed by the plastocene wall, is placed in a mixing bowl or pan. Plaster is added to the water. It is preferable to add the plaster by sifting it between the fingers to secure a uniform spread. Continue adding the plaster until small islands of plaster appear above the surface of the water.

Allow the mixture to stand for approximately five minutes, then stir until a smooth even mix is secured. Add more plaster slowly if the mixture is too thin. Pour half of the mix over the model and then pour it back into the mixing bowl. Break up all air bubbles, either with a brush or by blowing, making sure that no air is trapped in the deep recessions of the model (if any). When the entire surface of the model has a thin coating of plaster, then fill the depression with the balance of the plaster mixture. The mixture should be poured from one corner of the depression only. Care must be taken at this point not to trap air bubbles on the surface of the model.

A normal mix of plaster should set in about 20 minutes. Setting time of a plaster mix is related to water-by-plaster ratio. The ratio of water-to-plaster also affects the hardness of the set plaster. More plaster, in proportion to the water, produces a harder product.

The setting time of plaster is also affected by the mixing time. If a given proportion of water-to-plaster is mixed for 30 seconds, the plaster mix would set in about 20 minutes. If the same water-to-plaster proportion should be mixed for 1 minute, it would set in about 7 minutes. It is advisable to use ½ minute as a standard time for mixing. If setting is above 20 minutes, the next mix should receive more plaster in proportion to water and vice versa.

SESSION XII

AIM—To sandpaper, shellac and paint the finished plaster plaque.

MATERIALS

See Sessions V and VI.

PROCEDURE

Sandpaper down all irregularities. Apply shellac and allow at least 20 minutes for drying. Then bring out important structures by using contrasting paint colors.

SESSION XIII

Sessions XIII through XV cover casting prevulcanized latex in plaster molds. Latex models, in the future, will probably be the most widely used of all.

They are very easy to make and are not overly expensive. At the same time, they are practically unbreakable. Plaster of Paris models are cheap but they are extremely heavy and they break and chip very easily.

The principle, on which the making of latex models is based, is very simple. The liquid latex is poured into plaster molds. The plaster must be dry as it has to absorb the water in the latex. As the water passes into the plaster, the latex, lying next to the plaster, becomes a hardened shell. The latex, not in contact with the mold, remains liquid and is finally poured out. Eventually, the hardened shell shrinks and separates itself from the mold. The mold is then removed and the model, when dry, is painted.

To produce a successful latex model, one must have a good plaster mold of the desired object. Flat work, such as plaques without undercuts, can be cast in one-piece molds. Round objects require molds of two or more pieces.

AIM—To make a three-dimensional pattern in plastocene so that a rubber latex model may be made.

POSSIBILITIES FOR THREE-DIMENSIONAL MODELS IN LATEX

1. Tissues—bone, muscle, epithelial, etc.
2. Stages in embryonic development—egg, sperm, 2, 4, 8, 16, 32 celled stages, blastula, gastrula, & embryo
3. Heads of prehistoric men—Pithecantropus, Neanderthal, Crô-Magnon, etc.
4. Onion tissue
5. Massed Elodea cells
6. Veins showing valves
7. Fruits & vegetables—to be used as objective material in teaching nutrition
8. Meat cuts (for nutrition)

MATERIALS

1. A plyboard (2 ft. $\times 1\frac{1}{2}$ ft.) for each individual
2. Plastocene
3. Individual modelling tools
4. Paper towels and soap for hands
5. Hammers or mallets for pounding clay
6. Textbook drawings for reference

PROCEDURE

Make a 3-dimensional pattern in modelling clay as in Session I.

SESSION XIV

AIM—To place a flange around the pattern made in the previous lesson and to make a plaster mold.

MATERIALS

1. Pans
2. Plaster of Paris
3. Spoons
4. Newspapers to protect furniture
5. Strong soap solution
6. Sweet oil
7. Plastocene to make flange

PROCEDURE

Assume that the head of a prehistoric man has been modelled in plastocene at the previous meeting. The neck should be made longer than in reality.

Build a flange in plastocene around the head and neck. The flange should be about 2 inches wide and $\frac{1}{2}$ inch thick. Note that the flange must go around the widest part of the head. All undercuts must be avoided. It may be necessary to make a three-piece mold to avoid undercuts in certain models. Lay the head down and prop it in this lying position. Build up rather thick plaster over the face to a depth of two inches. Keep the plaster on the upper side of the flange. When the plaster has dried, pull the flange off. Gouge out 4 guide holes with a spoon in the plaster where the flange lay and rub this surface, which originally lay under the flange, with the strong soap solution. When this is absorbed, rub with a coat of sweet oil. Now turn the face, which is still in the plaster, downward and build up plaster to a depth of 2 inches over the back of the head and until it reaches the plaster over the face. This completes a two-piece mold. When dry, tap the mold gently and the two halves will drop apart.

SESSION XV

AIM—To use the plaster mold, previously made, to make a latex cast.

MATERIALS

1. Plaster mold
2. Liquid latex
3. Heavy cord

PROCEDURE

When the plaster mold is thoroughly dry and the modelling clay has been removed, prop it so that the head is upside down. Of course, the two halves of the mold must be tied together with the cord. Stir the liquid latex thoroughly and pour it into the neck until the mold is full. As the level sinks, keep refilling for about $\frac{3}{4}$ of an hour. Pour out all the remaining liquid now. Allow the shell of latex remaining in the mold to dry a little more. Remove the two plaster halves and set aside the permanent, hollow, latex model to dry thoroughly (48 hrs.). Cut off all unnecessary length on the neck. Mount the head on an attractive, wooden base. Paint in realistic colors. Shellacking is not necessary.

It is well to remember that the thickness of the latex crust that forms the model is determined by the length of time the latex stays in the mold. For example, if the latex is left standing for 15 minutes, a depth of $\frac{1}{16}$ of an inch is obtained. If more time is given, the model wall is thicker. The larger the model, the heavier the case required.

Never shellac any part of one of these plaster molds as the porous texture is then destroyed. The water from the latex is not absorbed and the latex shell does not form.

To make a round ball, as in the case of the egg mentioned previously,

insert a pencil into the plaster when the plaster mold is being made. Later, remove the pencil from the plaster and a pouring channel is left. At this hole, in the finished latex ball, there will be an opening. However, it can be plugged up with scraps of latex saturated with liquid latex after the model has thoroughly dried. Sandpaper the rough spot.

To make models of fruits and vegetables, form the plaster mold right over the natural product. Leave the pouring channel at the stem. If there isn't a stem, locate the opening at any convenient place. A sheet of latex can be made by pouring a thin layer of the liquid over a porous plaster surface. This sheet can then be cut into leaves, etc. The leaves may be fastened on with wire and latex solution may be flowed over the joints to conceal them.

There are many other types of model making and time, in one term, is limited. Doing work in balsa wood appeals to many of the boys. Large pieces of balsa can be carved into very fine models. These can then be painted and mounted on attractive bases made in the wood turning shop of the school. Animal tissues, the reflex arc, elodea, chromosomes with genes, a cross section of the spinal cord, etc., work up very well in balsa.

Even wax can be used to make biological models and some of the most beautiful ones at that, as all, who have seen them at the museums, know. One of the simplest ways to make them is demonstrated in the modelling of four o'clock flowers.

Take a small piece of modelling clay and form one of these flowers on a square of window glass. Mix and pour plaster over the clay flower to a depth of at least an inch. When the plaster is hardened, remove the clay and soak the plaster mold in water to fill all the pores. This step is extremely important. Heat some ordinary paraffin and beeswax ($\frac{1}{3}$ beeswax & $\frac{2}{3}$ paraffin) in a saucepan over a Bunsen burner. Use artists' colors to tint the melted wax. Fill the plaster mold with the melted wax which has been tinted. Let the wax harden and then remove the finished flower. The removal of the flower is facilitated if the mold with the flower is first placed in a pan of water to chill. Make a sufficient number so that they can be mounted to show Mendelian ratios. The white ones are to be made first. Then a little red should be added to the melted wax to give pink and finally more red to give a red color. Models of Andalusian fowl and guinea pigs work out well in this medium as very fine details, such as feathers and hair, can be brought out.

Wire loops can be made and inserted into the wax while it is still soft and the little figures can be hung on a wallboard to demonstrate the laws of heredity. Better still, they can be fastened to the wallboard with "Iron Glue" from the five and dime store to make good permanent mounts to decorate the walls of the classrooms and corridors of the biology department.

NOTE: Liquid latex can be purchased by the gallon, in normal times, from Saul Mirken, 125 4th Ave., New York City.

POTTERY MADE SUCCESSFULLY WITH MEXICAN VOLCANO'S LAVA

Paricutin, Mexico's volcano, as it ruins valuable framing land with its volcanic dust and lava, may be producing raw material for a new Mexican ceramics industry.

The pottery factory of the Anfora Company has just completed successful experiments with four tons of Paricutin lava, with the conclusion that it can be used in making pottery.

HOUSEHOLD SAFETY—A CHEMISTRY CLUB PROJECT

WILLIAM C. CURTIS
Dunbar High School, Washington, D. C.

PRE-VIEW

Today considerable emphasis is being placed on the necessity for making adequate defense preparation in the home. The current Civilian Defense program should serve to focus greater attention on the serious conditions that already normally exist in the home. Instead of teaching people to make their homes as safe as possible from the hazards of war, they should be taught to eliminate all household hazards.

Nearly one-third of all accidental deaths take place in the home. In 1938 there were approximately 31,500 fatalities from accidents in the home. Of this number, about 16,500 resulted from falls; 5,300 from burns; 2,600 from poisonings (including gas); 1,200 from suffocation; 1,000 from firearms; and 4,900 from other causes. Although these figures may be somewhat inaccurate, they do serve to give some idea of the nature and extent of the accident problem in the home. With civilization increasing in complexity, we should expect these figures to rise unless definite steps are taken to enlighten the public on all matters of household safety.

A high-school chemistry club can make a definite contribution in this connection by attempting to impart pertinent information pertaining to household safety to all persons in its community, from children to adults.

PRESENTATION

The maintenance of safety in the home involves a knowledge of the common causes of fires and home accidents and how they may be prevented; the acquisition of specific knowledge, habits, and skills which are at times needed in household emergencies; and the location and elimination of all household hazards. Should we undertake a project designed to encourage the people of our community to make their homes accident-proof, our first problem would be to determine,

1. How many people in our community know how to safeguard their homes against fire and explosions and prevent home accidents due to asphyxiation and suffocation, falls,

burns, scalds, chemical poisoning, firearms, and aerial attacks?

2. How many people in our community know how to administer first-aid in case of a household accident?
3. How many people in our community have taken the necessary precautions to safeguard their homes against fire and accidents?

The second problem would be to determine,

1. What steps can we take to impart the needed information to the people of our community?
2. What steps can we take to get the people in our community to cooperate with us in making their homes as safe as possible?

Procedure

I. Circulars explaining the nature and purpose of the project will be prepared and distributed among the people in the school community for the purpose of soliciting their cooperation.

II. Household safety pledges, check lists, and self-checking tests will be distributed to persons expressing a willingness to cooperate.

   A. Individuals signing the pledge will promise to do all within their power to save manpower by promoting safety in the home.

   B. On the check list the householder will answer questions about his home and actual practices. The check lists are to be filled out in duplicate. Each participant will retain one copy and return the other to the club.

   C. The test will be designed to measure one's understanding of the rules, regulations, laws, and practices involved in maintaining household safety. It will be in the form of a self-check sheet. Persons taking the test will score themselves with the aid of a key giving not only the answers but also the reasons for them. The key to be used for this purpose is to be constructed by the club members.

III. A good procedure for distributing and collecting the various forms is to allot them to the student body through their home rooms. The students could be urged to take this material home and fill it out themselves, or, preferably, have the head of their family to do so. The signed pledges, completed check lists, and test scores could be collected for

a period of about two weeks and a daily record posted showing the percentage of each home room taking part in the campaign.

IV. The club members will record and tabulate the check list and test scores. Shortly after the close of the campaign, each participating householder will be presented with an attractive certificate showing the distribution of scores.

V. Should this undertaking cause an appreciable number of the people in our community to become interested in promoting safety in the home, it would be a good idea to hold an Institute in Household Safety sometime during the school year. The purpose of this institute would be to disseminate relevant information on matters relating to household safety. What type of a program could the club work out for such an occasion?

Suggestions for Supplementary Projects

I. *Obtaining Pertinent Information on Safe Practices.*

"Safety Education," Amer. Assn. of School Admin., Washington, D. C., 1940.

II. *The Home Medicine Cabinet.*

American Red Cross First Aid Text-Book, Corrected Reprint, Amer. Red Cross, Washington, D. C., 1940.

"First Aid Supplies and How to Use Them," Circular, Amer. Med. Assn., Chicago, 1936.

Palmer, R. L., "The Home Medicine Cabinet," U. S. Govt. Print. Office, Washington, D. C., 1936.

III. *Household Poisons.*

Erb, R. C., *Poisoning the Public*, Dorrance Co., Philadelphia, 1937.

IV. *Causes, Control, and Prevention of Fire in the Home.*

"A Fire Prevention Manual for High Schools"

"Safeguarding the Home Against Fire"

"Safeguarding the Nation Against Fire"

V. *Flameproofing in the Home.*

Deutsch, N. L., "Modern Flameproofing," *Textile Colorist*, Sept., 1936.

"Fireproofing Christmas Trees," U. S. Dept. of Agr. Leaflet No. 193, Govt. Print. Office, Washington, D. C., 1939.

"Fireproofing Fabrics," U. S. Dept. of Agr. Farmers'

Bulletin No. 1786, Ibid., 1938.

Perry, A., "Fires That Need Never Happen," *The DuPont Mag.*, p. 4, March, 1942.

VI. *Use of Luminous Paint in the Home.*

Fluorescent Pigments Corporation, 445 West 41st St., New York, N. Y. (This firm manufactures a good grade of luminous paint and lacquer.)

Henley's Twentieth Century Book of Formulas, Processes and Trade Secrets, rev. & enlarged ed., The Norman W. Henley Pub. Co., New York, 1942, pp. 494, 495. (Directions for preparing luminous paints.)

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Dunbar High School

CHECK LIST

Survey of Accident Hazards in the Home

The purpose of this check list is to help you locate unsafe conditions and eliminate hazards around your home. Be your own home inspector. Make a careful survey of your home and then answer the questions listed below by placing a check (√) in the space after "Yes" or "No." After you have answered the questions, determine your score as directed at the end of the questionnaire.

Falls and Broken Bones

1. Are all stairways and fire escapes free from incumbrance? Yes ____ No ____ 1.
2. Are all stairways adequately lighted? Yes ____ No ____ 2.
3. Are all stairs and porches equipped with sound railings? Yes ____ No ____ 3.
4. Are small rugs secured against slipping? Yes ____ No ____ 4.
5. Are all floors sound? Yes ____ No ____ 5.
6. Is toilet soap kept in a container? Yes ____ No ____ 6.
7. Do you have a stepladder in good repair and easily accessible? Yes ____ No ____ 7.
8. Is a rubber mat provided for the bathroom? Yes ____ No ____ 8.
9. Are brooms, sweepers, or mops stored in a suitable closet? Yes ____ No ____ 9.
10. Are ice, snow, grease, and other slippery materials removed from the stairs, floors, and walks promptly? Yes ____ No ____ 10.
11. Are electric light cords fastened down where persons may trip over them? Yes ____ No ____ 11.

Fire, Burns, and Scalds

12. Has your heating equipment been inspected and cleaned within the

year? Yes ____ No ____ 12.
13. Is the attic, basement, and garage free from rubbish? Yes ____ No ____ 13.
14. Are non-inflammable ash trays distributed throughout the house? Yes ____ No ____ 14.
15. Do you have an approved fire extinguisher or fire buckets filled with sand or water easily accessible? Yes ____ No ____ 15.
16. Are the hot-water pipes lined with asbestos or other insulating material? Yes ____ No ____ 16.
17. Are the walls and other woodwork in the attic and basement whitewashed? Yes ____ No ____ 17.
18. Are matches kept in a safe place, such as a metal container, and out of the reach of children? Yes ____ No ____ 18.
19. Do you keep the handles of kitchen utensils on the stove turned in from the front and sides of the stove? Yes ____ No ____ 19.
20. Are dust mops, oily dusters, and cleaning cloths kept in tightly covered metal cans or hung so as to be surrounded by plenty of air? Yes ____ No ____ 20.
21. Are metal containers used for ashes and rubbish? Yes ____ No ____ 21.
22. Are flammable liquids ever used for dry-cleaning in the home? Yes ____ No ____ 22.
23. Are flammable liquids such as gasoline, kerosene, benzine, benzene (benzol), or carbon disulphide, and painting materials stored in the home? Yes ____ No ____ 23.
24. Are combustile materials kept away from stoves and out of contact with stove pipes and open flames? Yes ____ No ____ 24.
25. Are all pull chains equipped with insulating links? Yes ____ No ____ 25.
26. Are all electrical fixtures properly fused? Yes ____ No ____ 26.

Asphyxiation and Suffocation

27. Have all gas fixtures been installed by an authorized mechanic? Yes ____ No ____ 27.
28. Are all gas connections substantial? Yes ____ No ____ 28.
29. Is care taken to protect gas flames from sudden gusts of wind? Yes ____ No ____ 29.
30. Is care taken to prevent gas flames from being extinguished by liquids boiling over? Yes ____ No ____ 30.
31. Are all gas appliances in safe working condition? Yes ____ No ____ 31.
32. Do you ever start the motor of an automobile in a garage when the door is closed? Yes ____ No ____ 32.

Electric Shock

33. Have all connecting cords that have insulation worn off at any place been repaired or replaced? Yes ____ No ____ 33.
34. Do you disconnect such appliances as irons, portable heaters, curling irons, etc., immediately after you are through using them? Yes ____ No ____ 34.
35. Do you use only electrical appliances approved by a responsible electrician or the Underwriter's Laboratory? Yes ____ No ____ 35.
36. Are all electrical connections out of the reach of the bathtub? Yes ____ No ____ 36.
37. Do you ever handle electrical fixtures with wet hands? Yes ____ No ____ 37.

38. Is makeshift wiring used along the base boards, under rugs, etc.?
Yes ____ No ____ 38.
39. Are defects in electric appliances repaired promptly?
Yes ____ No ____ 39.

Chemical Poisons, Bleeding, and Infection

40. Have you disposed of all unnecessary poisonous substances in the home? Yes ____ No ____ 40.
41. Is the home medicine cabinet located out of the reach of children?
Yes ____ No ____ 41.
42. Are all medicines in the cabinet labeled accurately?
Yes ____ No ____ 42.
43. Are all poisons clearly identifiable even in the dark?
Yes ____ No ____ 43.
44. Does the medicine cabinet contain the proper first aid equipment?
Yes ____ No ____ 44.
45. Does your medicine cabinet contain an assortment of old prescriptions and other miscellaneous junk? Yes ____ No ____ 45.
46. In employing fluids for removing occasional spots and stains, do you use them in a well-ventilated room or outdoors?
Yes ____ No ____ 46.
47. Are sharp kitchen knives and cutting gadgets kept in a separate drawer or partition of the drawer? Yes ____ No ____ 47.
48. Do you dispose of broken glass promptly and in a safe place?
Yes ____ No ____ 48.

Gun Shot Wounds

49. Are all firearms unloaded? Yes ____ No ____ 49.
50. Are all firearms out of the reach of children? Yes ____ No ____ 50.

Aerial Attack

51. Do you have a firefighting kit for combating incendiary bombs?
Yes ____ No ____ 51.
52. Have the cracks of your attic floor been filled with some non-flammable crack filling material, such as plaster of Paris, asbestos cement, etc., or covered with a good linoleum rug? Yes ____ No ____ 52.
53. Do you have a prepared refuge room? Yes ____ No ____ 53.
54. Have you made the necessary preparation for blacking out the home?
Yes ____ No ____ 54.
55. Have your draperies and curtains been flameproofed?
Yes ____ No ____ 55.
56. Have danger spots, such as stair treads, been painted with luminous paint? Yes ____ No ____ 56.

Directions for Scoring. For a perfect score you must be able to answer "Yes" to all questions except numbers 11, 22, 23, 32, 37, 38, and 45; and "No" to these questions. You get one point for each correct response. Determine your total number of satisfactory responses. This is your score.

Householder's Name _____ Score _____
Address _____ Date _____

When you change address be sure to notify Business Manager Ray C. Soliday, P. O. Box 408, Oak Park, Ill.

NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG
Hyde Park High School, Chicago

(*Continued from the November issue*)

61. The Third Semester of Algebra. I use this title to avoid misunderstanding; in some schools this course is called Intermediate Algebra, and in the middle-west the title Advanced Algebra is used. The course follows a year's work in algebra and a year's work in geometry, and is a prerequisite to trigonometry and solid geometry. In too many schools the intermediate algebra is merely a review of first year algebra. Hence I present an outline of the third semester prepared by my colleague, Miss Shoesmith. We have followed the outline a good many years and know that this work can be done. The contents are presented in the form of eighty-nine lessons.

I. Introduction.

1. Order of operations. Evaluation of expressions and formulas for positive, negative, integral and fractional numbers.

2, 3. Removal and insertion of parentheses. Multiplication and division of polynomials.

4. Special rules for multiplication.

5. Linear equations in one variable with checks.

6. Literal linear equations in one variable with checks.

7, 8, 9. Verbal Problems.

II. Factoring.

10. Monomial factors.

11. Perfect squares. The difference of two squares.

12. Changing a form to make a difference of two squares.

13. The quadratic trinomial.

14. The sum and difference of odd and even powers.

15. The Remainder Theorem and the Factor Theorem.

16, 17. Miscellaneous cases.

18, 19. Equations solved by factoring: literal, quadratic, and of higher degree.

III. Fractions.

20. H.C.F. and reduction to the lowest terms.

21, 22. Changes in sign. L.C.M. Addition and subtraction.

23. Multiplication and division.

24. Complex fractions. Combinations of the operations.
25, 26. Fractional equations.
27. 28. Verbal problems leading to fractional equations.

IV. Proportions and Variation.

29, 30, 31. Direct and inverse variation, with applications.

V. Linear Systems.

32, 33. Systems in two variables.
34. Graphic representation.
35, 36. Reciprocal and literal systems. Systems in three or more variables.
37, 38. Verbal problems using two or more variables.

VI. Radicals.

39. Methods of simplifying radical expressions.
40. Addition and Subtraction.
41. Multiplication.
42. Division. Rationalizing the denominator.
43. Square root.
44, 45. Application to geometric figures and variation.

VII. Exponents.

46. Negative, zero, and fractional exponents.
47. Simplifying quantities involving these exponents.
48, 49. Multiplication and division, with unusual exponents.
50. Exponential equations.

VIII. Logarithms.

51. The meaning and language. Rules for the characteristic.
52. Interpolation. Use of tables.
53, 54. Multiplication, division, powers, roots.
55. Combinations of the operations.
56. Exponential equations solved by logarithms.
57, 58. Applications, including compound interest.
59, 60. The slide rule.

IX. Graphs.

61, 62. Linear, quadratic and cubic functions.

X. Quadratic Equations, numerical and literal.

63. Solved by factoring.
64. Solved by completing the square.

65. Solved by the formula.
66. Miscellaneous types.
67, 68. Verbal Problems leading to quadratics.
69. Relations between the roots and the coefficients.

XI. Complex Numbers.

70, 71. Meaning. Simplification. Various operations.

XII. Irrational Equations.

72, 73. Solved by squaring one member, by transforming to a quadratic. Extraneous roots.

XIII. Simultaneous Quadratics.

74. One linear and one quadratic.
75. Two quadratic equations.
76. Special methods for sets.
77. Graphic of circle, ellipse, parabola, hyperbola.
78. Verbal problems leading to simultaneous quadratics.

XIV. Arithmetic Progressions.

79. Definition. Formula for L.
80. Insertion of arithmetic means.
81, 82. Formula for S. Verbal problems.

XV. Geometric Progressions.

83. Definition. Formula for L.
84. Insertion of geometric means.
85. Formula for S. Sum is an infinite G.P. with $r<1$.
86, 87. Applications.

XVI. The Binomial Theorem.

88. The theorem for positive integral exponents.
89. Finding the rth term. Applications.

If we favor pure food laws and the correct labeling of canned goods, then we should favor having intermediate algebra mean something definite. Variations, of course, are always possible in the order of the topics and, in a lesser degree, in the amount of time devoted to each topic.

For example, I do not like to scatter literal equations and problems until they have been introduced under a topic like Generalizing. And I would prefer to treat all graphs at one time, omitting any reference to them when working with sets of linear

equations. In the work on factoring, I prefer to treat the trinomial square and the difference of two squares as a special case of the general trinomial.

Variations in time allotments can also be expected. The Factor Theorem may need two days instead of one. I would combine lessons 32 and 33 into one lesson, and add a day to sets of literal equations and sets in three unknowns. Lessons 53 and 54 may take three days, and 59 and 60 may be combined into one. Finding the rth term of a binomial expansion seems less important than applying the theorem to a fractional value of n. Further, a short outline cannot specify half days; thus the question of inserting arithmetic means does not need a whole day.

In the *Mathematics Teacher*, March 1927, an article by Reeve discusses the objectives in intermediate algebra; and in the December, 1927, issue of the same journal I presented an outline, also in eighty-nine lessons. Although written sixteen years ago the difference in the eighty-nine lessons is slight. From this we may conclude that the course has changed little or that I have not improved. I note, however, that in 1927 I wrote "Since many pupils . . . have never done any work on graphs even in the ninth grade, this subject must be presented thoroughly." Now I would say, "Since graphs are over-emphasized in the ninth grade, little time need be spent on this kind of work."

Ninth grade algebra and tenth grade geometry are not the same to-day as ten or fifteen years ago. The introduction of courses in general mathematics has removed from algebra classes many pupils who hindered the progress of the other pupils. It should be possible to-day to make intermediate algebra more than a review of elementary algebra. The topics, the time allotment (but not the order of the topics) may be summarized as follows:

1. Introduction. 6 days.
2. Factoring. 7 days.
3. Fractions. 6 days.
4. Equations and Problems in various places. 10 days.
5. Dependence, including variation. 3 days.
6. Linear systems. 6 days.
7. Radicals. 5 days.
8. Fractional exponents. 4 days.
9. Logarithms. 10 days.

10. Graphical work of various kinds. 3 days.
11. Complex numbers. 2 days.
12. Quadratics and sets of quadratics. 11 days.
13. Irrational equations. 3 days.
14. Arithmetic and Geometric Progressions. 9 days.
15. Binomial Theorem. 4 days. Total: 89 days.

The topic of logarithms needs special mention. I would make any sacrifice in any topic rather than omit the work on logarithms. The topic should be placed near the middle of the semester, and thereafter the pupils should do some logarithmic computing every week (or one problem a day) so that they can do this work easily when they enter the class in trigonometry.

FRUITS OF TROPICAL GUAVA SHRUBS HAVE HIGH VITAMIN "C" CONTENT

Guava powder, obtained from the fruits of a neglected tropical shrub, is now being used by British troops as a rich source of vitamin C, and research in the United States indicates that the fruits may become more popular here.

Dried guava is so rich in vitamin C that a little over four ounces would protect an Arctic explorer from scurvy for almost three months. In the forthcoming Handbook of Nutrition, to be published by the American Medical Association, Dr. Russell M. Wilder and Thomas E. Keys of the Mayo Clinic point out that the powder is reputed to contain a "rather phenomenal quantity of ascorbic acid (vitamin C), 2500 to 3000 milligrams per 100 grams," according to research reports from South African laboratories.

Researchers, working at the South African Institute for Medical Research and the Government Chemical Laboratories in Johannesburg, found that the vitamin could be preserved best by blanching the unpeeled quartered guavas after the central pulp and stones have been removed. Then the fruit is dried at 130 degrees Fahrenheit for 10 to 12 hours and powdered. The product is pleasantly aromatic but has little taste.

Vitamin C was found to be at the high level of 2.5% to 3%, even exceeding such rich sources as dried rose hips, which are reported to contain about 2%.

Other researchers have found that the rich vitamin content is lost rather readily in warm climates. Fresh guavas are little affected by stewing, however, and canned guavas proved stable.

Guavas of different varieties grow wild profusely in the tropics and vary widely in their vitamin C content. Natives remove the seeds of the fruits, add sugar and boil the fruit down to a paste.

Guava paste and jelly are made in Florida, too, where the fruits grow fairly well. At the California Experiment Station in Riverside, hundreds of guava trees have been bearing fruit, many since 1918. They are a hardy lot, with what Dr. H. J. Webber of the Experiment Station calls the habits of a weed. The plants thrive in almost any type of soil from sterile and coarse to rich and loamy, and from very dry to very wet. California experiments reveal that cold is about the only "limiting hazard."

A plant for dehydrating guava fruits is now nearing completion in Cuba.

PROLATE AND CURTATE

A. H. BEILER
Cooper Union Institute of Technology,
New York, New York

A foreigner learning that in English ravel and unravel mean the same thing, would be no more confused than a mathematics student trying to master the nomenclature connected with the trochoids—the lesser known members of the cycloid family. Mathematicians, who pride themselves on their consistency, should hold court and lay down the law so that all writers of text books hereafter may adhere to their decree. Once and for all there should be settled the question as to when a trochoid is prolate and when curtate (or is it oblate?)

A cycloid is the locus of a fixed point on the circumference of a circle which rolls along a fixed line. If the fixed point lies within or without the circle (in the latter case on a radius extended) the curve is called a trochoid. If "a" is the radius of the circle and "b" the distance from the center to the fixed point, it is easy to show that parametric equations defining the trochoid are:

$$x = a\phi - b \sin \phi$$

$$y = a - b \cos \phi$$

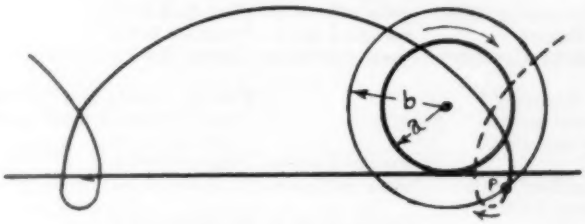
where $a \neq b$.

To this extent all authors are agreed. There is also not the slightest doubt that if the trochoid is plotted, it will have a loop in it as in Figure 1 when "b" is greater than "a" and it will be devoid of this loop as in Figure 2 when "b" is less than "a." The path of a point on the flange of a locomotive wheel is the common example of the *looped* trochoid; the path of the center of the pin joining the connecting rod to the driving wheel on the locomotive is an example of the *loopless* one.

One of these curves is called a prolate cycloid; the other is a curtate cycloid. Which is which? Try guessing. Prolate—prolonged. Curtate—curtailed. It would appear then that in the prolate curve the distance from the center to the moving point is prolonged, that is, "b" is greater than "a"; in the curtate it is curtailed and "b" is smaller than "a." It certainly sounds plausible. So we consult Webster's *New International Dictionary* 1926 edition. "Prolate—stretched out, extended"; "Curtate—comparatively short or shortened." Apparently nothing could

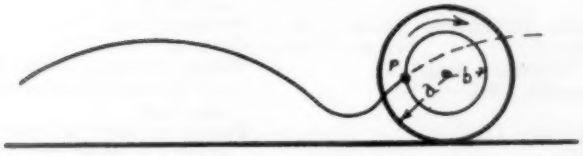
be simpler. And then on page 558 it clearly says under "cycloid," "It is called common, curtate or prolate according as the generating point is on, without or within the circle." A diagram is given showing that the looped curve is called the curtate cycloid and the loopless one, the prolate.

Messrs. Kasner and Newman in their book, *Mathematics and the Imagination*, Simon and Schuster 1940, page 198, say, "An inner point of the wheel which rolls on a straight line describes the prolate cycloid." A diagram shows this as a loopless curve. " . . . The path traced by a point outside the circumference such as the outermost point of the flanged wheels used on rail-



TROCHOID b>a

FIG. 1



TROCHOID b<a

FIG. 2

way trains . . . is a curtate cycloid." Another diagram shows this curve as being looped. This agrees with the dictionary. For further confirmation we consult a few mathematical text books and in growing bewilderment find that some writers call the curve curtate when $b>a$ whereas others call it prolate. The encyclopedias and engineering handbooks are similarly contradictory.

Table 1 lists some of the references consulted. Authors who believe that the curtate is the looped curve have been classed as A; those who believe it is the prolate that is looped have been rated B.

What shall be done about it? No empires will be rocked by these inconsistencies nor can the student's difficulty in deriving the parametric equations be attributed to this confusion in

TABLE 1

Authority	*Equation*	*Nomenclature*	*Class*
Wilson & Tracey Analytic Geometry. 1915.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if point is without circle and curtate when point is within.	B
Smith, Gale & Neeley New Analytic Geometry. 1928.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $a>b$. Curtate if $a<b$.	A
Sisam Analytic Geometry. 1936.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b>a$. Curtate if $b<a$.	B
Mason & Hazard Brief Analytic Geometry. 1935.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b>a$. Curtate if $b<a$.	B
Kasner & Newman Mathematics and the Imagination. 1940.		Prolate if point is within circle. Curtate if point is outside of circle.	A
Marks Mechanical Engineers Handbook. 1930.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b<a$. Curtate if $b>a$.	A
Eshbach Handbook of Engineering Fundamentals. 1936.	$x=a\phi-b\sin\phi$ $y=b(1-\cos\phi)$*	Prolate if $b>a$. Curtate if $b<a$.	B
Webster's New International Dictionary. 1926.		Prolate if point is within circle. Curtate if point is without circle.	A
Encyclopedia Britannica, 14th edition.	$x=a\phi+b\sin\phi$† $y=a-b\cos\phi$	Prolate if $b>a$. Curtate if $b<a$.	B
Century Dictionary and Encyclopedia. 1904.		Prolate if point is within circle. Curtate if point is without circle.	A
Oxford English Dictionary. 1933.		Prolate if point is within—curve has inflections. Curtate if point is without—curve has loops.	A
New International Encyclopedia. 1935.		Prolate if point is within. Curtate if point is without.	A
Curtis and Moulton Analytic Geometry. 1930.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b>a$. Curtate if $b<a$.	B
A. S. Hardy Elements of Analytic Geometry. 1888.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b<a$. Curtate if $b>a$.	A
A. Cohen Differential & Integral Calculus. 1925.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b<a$. Oblate if $b>a$. "The prolate trochoid has neither cusps nor loops."	A
C. H. Lehmann Analytic Geometry. 1942.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b>a$. Curtate if $b<a$.	B
R. S. Burington Handbook of Mathematical Tables and Formulas. 1940.	$x=a\phi-b\sin\phi$ $y=a-b\cos\phi$	Prolate if $b>a$ Curtate if $b<a$.	B

* This is obviously incorrect.

† This equation defines the cycloid whose vertex is at the origin but does not affect the point under discussion.

terms. But some house-cleaning is surely indicated. Is there room for any discussion? Shall it be put to a vote? The author votes with Webster, the Oxford, Marks, et al. and against the *Encyclopedia Britannica* and others of the B class.

SOME THOUGHTS ON POLYHEDRONS

GERALD FREILICH

1235 East 13th Street, Brooklyn, New York

The usual type of problem involving the numbers of vertices, edges, and faces of a polyhedron can be solved by a simple substitution in the well known Euler's formula $V+F=E+2$. While working on these problems, I thought of a number of others which to my mind were much more useful and interesting and which I could not solve by use of the above formula. To me a question such as: Can a crystal bounded by only three pentagons and four triangles ever be found in nature? is more exciting than to show that for any existing polyhedron, $V+F=E+2$.

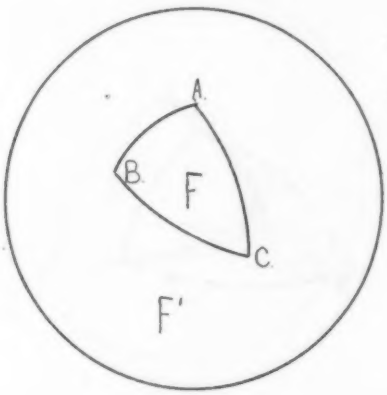


FIG. 1

THEOREM

In a polyhedron bounded entirely by triangles, two or more of which may be co-planar, the number of edges equals 3/2 the number of faces.

NOTES

1. If a face is a polygon of n sides, it should be considered as being composed of $(n-2)$ triangles which can be formed by drawing all possible diagonals from one vertex.

2. In order to study the relationship between the numbers of edges and faces of a polyhedron, I found it advisable to project the polyhedron on a surrounding sphere by lines from the center of the sphere through the vertices of the polyhedron.

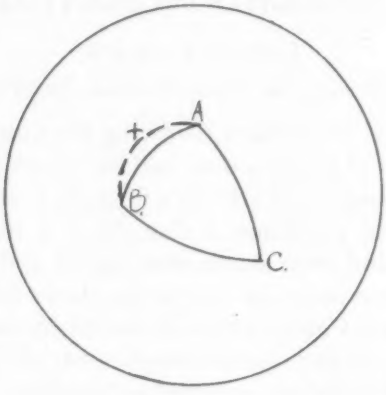


FIG. 2

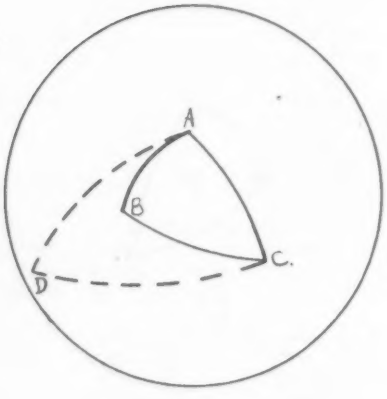


FIG. 3

Thus there is set up a one-to-one correspondence between the vertices, faces, and edges of the polyhedron and the corresponding elements of the figure on the sphere.

Beginning with the simplest case of a polygon on a sphere, namely with triangle ABC (see Fig. 1), we have the sphere di-

vided into two triangular faces (F and F') and three edges, AB, BC, and AC.

To get the next case (a polygon having the next larger number of triangles), we first try to add only one edge (see Fig. 2). Let this be AXB. But this is impossible according to the conditions of the theorem since it creates a figure bounded by two

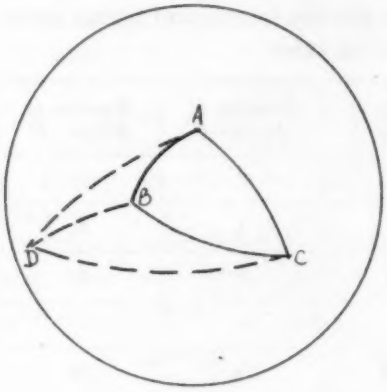


FIG. 4

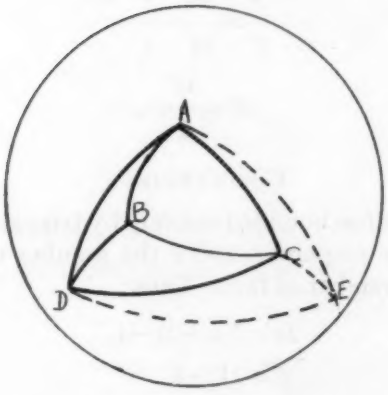


FIG. 5

sides and not by three. We then try to add two edges, namely AD and DC (see Fig. 3). But this figure again doesn't satisfy the conditions of the theorem because $ABCD$ is a quadrilateral and not a triangle. This can be remedied by drawing BD (see Fig. 4). Thus, I have the next case, formed by adding three edges and two faces to the figure in the previous case.

Now to get the third case, we can think of triangle ADC alone and temporarily forget about the other triangles within ADC. Hence, in order to add edges, vertices, and triangular faces to figure ADC, we follow the same procedure as before because ADC is outwardly a triangle. Therefore, to get the third case, (see Fig. 5) we must add three more edges, EA, EC, and ED, and as a result we have two more faces, ACE and DCE. In the same manner we get the fourth and higher cases.

We thus have the table:

Case	*Number of Vertices—V*	*Number of Faces—F*	*Number of Edges—E*	*Ratio E/F*
1	3	2	3	3/2
2	4	4	6	3/2
3	5	6	9	3/2
—	—	—	—	—
n	$n+2$	$2n$	$3n$	3/2

From the table, it can be seen that

$$\frac{E}{F}=\frac{3n}{2n}=\frac{3}{2}.$$

Therefore

$$E=\frac{3F}{2}.$$

COROLLARIES

1. In a polyhedron bounded entirely by triangles, two or more of which may be co-planar, twice the number of vertices less four equals the number of faces. Thus:

Since $2n=2(n+2)-4,$

therefore $F=2V-4.$

2. In a polyhedron bounded entirely by triangles, two or more of which may be co-planar, three times the number of vertices less six equals the number of edges. Thus:

Since $3n=3(n+2)-6,$

therefore $E=3V-6.$

The usefulness of this theorem and its corollaries can be shown

in the following example. In finding the number of vertices in a polyhedron consisting of, let us say, three pentagons and five triangles, we divide the three pentagons into nine triangles. As a result, we have a polyhedron of fourteen triangles or faces. By using $F=2V-4$, we find the number of vertices to be nine.

Still another use that can be made of these formulas is the determination of the possibility of building a polyhedron under certain given conditions. Take for example the question mentioned at the beginning of this article as to whether a polyhedron can be constructed using three pentagons and four triangles. Considering the three pentagons as composed of nine triangles, we have thirteen faces. Substituting in the formula, $F=2V-4$, we get $V=8\frac{1}{2}$. Therefore such a polyhedron is impossible of construction.

Finally it is interesting to note that Euler's theorem itself can be derived from the above formulas as follows:

1. From the theorem, we have

$$F=\tfrac{2}{3}E.$$

2. From corollary two, we have

$$V=\frac{E+6}{3}=\frac{E}{3}+2.$$

3. Adding steps 1 and 2, we have

$$F+V=E+2.$$

NEW AIRPLANE COMPASS

A new airplane compass has been developed which is not thrown off by the bombload, armor plate, or other metal parts of the plane, it was announced at the Philadelphia Division of Bendix Aviation Corporation. Motion of the plane does not affect it either.

"This new compass will not go off its reading when the plane dives or climbs rapidly, it will not lay or overshoot during a turn and it will not oscillate or 'hunt' back and forth in rough weather," the designer, W. A. Reichel, explained.

The Gyro Flux Gate Compass uses the earth's magnetic field to develop minute electrical impulses which, when amplified, turn the compass indicator. The transmitter can be located at a distance from the master indicating dial. The principle of the gyroscope is employed solely for stabilization.

This revolutionary type of compass is "as great an advance over the conventional magnetic compass as that compass was over the lodestone," Mr. Reichel said.

THE SCIENCE SURVEY

DAVID J. SEVERN
7600 Harrison St., Forest Park, Illinois

In the past decade the survey course of the junior college has been eminently successful and consequently widely adopted. In the sciences the division of subject matter into biological and physical sciences has found little difficulty from overlapping of the two fields. It is, however, recognized that certain subjects which find their place in the study of social sciences have part of their content in natural science. Illustrations are: anthropology, whose physical aspect is biological, and geography, which has aspects which may be considered under both biological and physical sciences. There is a certain reticence to permit more than a minimum of overlapping between the two fields. This appears to be both a cause and an effect of departmentalization. A widely used junior college textbook openly proclaims its coverage of Physics, Chemistry, Astronomy, and Geology, and proceeds to treat these subjects as four short elementary courses. The surveys, for the greater part, are becoming stabilized, sometimes to an unwise degree.

The present organization of the physical science survey, except for its tendency toward departmentalization, is logical. The descriptive aspects found in the material on astronomy and geology are dependent upon dynamic phenomena which in most cases are discussed previously in the course. In the biological sciences, however, a large body of the material is dependent for complete understanding on previous knowledge of physics and chemistry. Since biological science is usually better adapted to elementary teaching, it is more often taken in the freshman year, leaving all but the most simple aspects of the basic physical sciences, upon which it is based, for later explanation in another course.

The treatment of physiology, for instance, ranges from courses which spend considerable time throughout the discussion in introducing physical principles (time which could have been saved had the physical sciences course been taken first), to courses which attempt to avoid confusion and in doing so reduce the amount of physical theory to the extent that they become no more than courses in hygiene. In the physical science survey, on the other hand, geology is usually studied at or near the close of the course. Geological phenomena are dependent upon physics

and chemistry, but not to the same extent as biology. The amount of geology included is usually such that the basic physical principles behind it are known, or assumed, by most people, certainly by all high-school graduates. These defects of the present surveys are obvious, but not remediable, superficially, to an extent that would make drastic change worth while. It would be possible, however, to approach natural science from a different viewpoint than the present one. Is the conception of the division of natural science into the study of live phenomena and non-living phenomena so important? It may be possible that just from the adoption of the viewpoint that it is important, a considerable part of the effectiveness of the motivation of the student by the teacher is lost. The distinction between living and non-living things is an obvious one, but few students just beginning college see the importance of it as a criterion for division. There is a similarity in method of study of certain sections of the physical science course with sections of the biological science course which each course does not find within itself. There are the sections of both courses which are concerned with dynamic phenomena: in physical science, physics, chemistry, and celestial mechanics; in biology, physiology and the greater part of ecology. Likewise in both courses there are sections which adopt an historical approach; in physical science, stellar and solar origins and historical geology; in biology, the evolution of the plant and animal kingdoms. Supplementing historical geology is the study of geological processes; supplementing historical biology is the study of evolutionary processes—genetics.

The place of geography is difficult because its scope includes biological, physical, and social sciences, and the subdivision of material in these three courses is not mutually exclusive except from the distinction in point of view.

Why not, then, substitute for the present division of natural science a division into the historical aspect (natural history), and the dynamic aspect (functional or dynamic science)?

A suggested outline for Natural History is:

1. The theories of the origin of the earth.
2. The "destructive" and "constructive" processes of geology.
3. Geological history of the earth.
4. Present surface features of the earth.
5. The evidences and mechanisms of organic evolution.

6. The evolution of plants.
7. The evolution of animals.
8. The evolution of man.
9. The present distribution and classification of man.

Exclusion of dynamic science would not here be complete considering the inclusion of mechanisms of geologic and organic evolution, but these subjects must properly be considered as an integral part of the historical method in any case.

The course in dynamic science would then cover:

1. A consideration of the laws of physics.
2. The mechanics of heavenly bodies as illustrating the work ing of physical laws.
3. A consideration of chemical laws.
4. A consideration of the functions, both normal and pathic, of living things, as illustration of the physico-chemical working of nature (including consideration of psychology, as the ultimate of dynamic balance).

By adopting these courses, the following would be accomplished:

1. The present dependence of biological sciences on physical sciences would be eliminated. The two science surveys would be mutually independent. This would be advantageous, especially when the surveys are considered as terminal general education.
2. Each course would become more elastic. It would be possible to expand or contract the courses (without obscuring the motivation) to a much greater extent than with the present courses.
3. A definite point of view would follow through each of the courses. The Natural History course could be likened to the vertical view of natural science, "dynamic" science to the horizontal. A parallel can be drawn with the surveys of Humanities (vertical view of society and culture), and Social Sciences (horizontal view).
4. Since most applied sciences are "dynamic" sciences, consideration of application of science to industry, medicine, conservation, etc. can be considered in the dynamic science course, rather than loosely considered in both courses.
5. Students who intend to pursue specialized courses in

scientific fields will obtain a philosophical perspective of the position of their field in the great general body of knowledge.

THE CONFERENCE ON POST-WAR EDUCATION

Give us the tools and all possible help and we'll do the educational reconstruction job ourselves.

This, in effect, is what members of the International Education Assembly, representing (unofficially) Poland, Greece, Czechoslovakia, China, and other United Nations, told American educators meeting at Harpers Ferry to outline recommendations for post-war school policies.

The American educators constituted the Liaison Committee for International Education. Its chairman is Dr. Grayson N. Kefauver, dean of Stanford University's School of Education.

One after another, representatives of invaded countries rose to paint before the Liaison Committee the devastation wrought by Hitler and Tojo upon their homeland schools. But all emphasized that the spirit of their peoples is not crushed; that youth is carrying burdens of war together with adults; and that each country wishes to rebuild and reconstruct its own school systems—but will need help from victorious United Nations.

Pattern of Destruction

European educators testified that the destruction of their schools was deliberate, and carried on "with scientific fury." The Nazi plan, said Thaddeus Mitana of Poland, was to reduce the Eastern European peoples to the status of slaves. Because "slaves are more useful when they can read and write," only elementary education was to be permitted in these countries. Universities and secondary schools of Poland, Greece, Czechoslovakia, and Eastern Russia were to be eradicated.

"We plan to make Poland an intellectual desert," boasted the Nazi Governor of Poland, according to the testimony of one member of the Assembly.

Countries west of Germany were permitted to operate a limited number of secondary and higher schools. But in all conquered countries libraries were destroyed; "non-Ayrian" books burned; historical and scientific documents stolen; laboratory apparatus and equipment carted away to Berlin and other German cities; teachers terrorized; pupils suspected of being anti-German taken out of classes never to be seen again.

A Czech physics textbook was banned because it contained a footnote on Einstein's theory of Relativity; a school reader was thrown out of the schools because it contained the sentence, "Herman pushed Adolf into the water."

UNDERGROUND STORAGE TANKS

Vast underground storage tanks to hold millions of gallons of aviation gasoline and other petroleum fuels are being built at coastal points and naval outposts. They are made of bombproof concrete, and lined with synthetic rubber sheets to prevent leakage and chemical action between the gasoline and the concrete.

TRUTH AND ETHICS IN TEACHING SCIENCE

WM. J. TINKLE
La Verne College, La Verne, California

The self-appointed guardians of ethics, the teachers of religion, have not always agreed with us, the teachers of science. There has been a tendency for us to feel that they were ill informed, and for them to feel that we were not so advanced in moral interest as they. It is true that religion, if it be the right kind, does furnish motive power for ethics, but the scientist's unprejudiced search for truth also tends toward good ethics. Ethics belongs to us as well as to the theologians.

We teachers have objected to the limitation of investigation. Our emotions still writhe within us when we read of Galileo being forced by the ecclesiastics of his day to recant his belief in the new discoveries. A friend said to him, "I have searched diligently in Aristotle and find that he makes no mention of spots on the sun; therefore you should not believe in them any more, even though you do seem to see them through your telescope." While this attitude has decreased tremendously it has not ceased entirely. Only a few years ago a clergyman said to me, "Scientists go to great lengths to speculate as to how coal was formed from the remains of plant life. I prefer to think that God placed it there." Certainly! but is it not interesting to learn how?

For the theologians to teach an out-moded science in the name of religion is dangerous. Not that it is an obstacle to the science teacher, for in the white light of the laboratory the grotesque views of the student dry up, shrivel up, and blow away. But the former views of the student had been a foundation for his character, his organized integrity, his philosophy of life, his religion—call it what you will—and this goes down along with his false science. He becomes like a wandering ship with no voyage planned nor even reliable maps. This, my friends, is not a light matter.

Now it is not my purpose to bring accusations against any group of people but to recount the facts involved, so that all parties concerned may work together for better ethics. My own experience has been rather free from mental conflicts, since my denomination, the Church of the Brethren, never has adopted any stringent attitude toward science. Fortunately also my

association with religious leaders during my teaching has been amiable. Can we not forget the skirmishes of the past and resolve to cooperate with any who will work with us for the building of stronger characters?

We stated above that a student's early religious teaching should contain nothing that will be broken down by science. True science will not break down faith, since a scientist depends so much upon faith. We have faith that our universe, the world in which we live is an orderly world, is dependable; that if we put hydrochloric acid and sodium hydroxide together today they will form sodium chloride and water just as they did yesterday; and that if we build a fire it will make the room warm, although we should be in a corner if forced to prove these results as we prove a theorem in geometry. The pagan who worships fetishes does not have that faith but thinks that whatever gods there are may be bought off by his bribes or tripped by his trickery.

Faith is not credulity, since we should believe only that which is supported by facts. At this point the emphasis of science is much in place, insisting that we should wait for evidence before we believe. Once the evidence is given we should hold on to our belief. Why not help your students in this age of doubt by explaining that in science we live by faith as well as in Christianity? A science teacher should not consume much time with such statements, for a scientist is not dealing with creations of men but with the handiwork of God but it is worth while to put faith in its true place. If the lack of it becomes widespread we have a financial panic, and if a person loses faith in everything he is sent to a hospital for the insane.

The marvelous mechanisms of plants and animals speak to us of the Creator. Consider the self-regulating heat mechanism of the human body, balancing such heating and cooling devices as oxidation, friction, panting, perspiring, and pulse rate so that the internal temperature is kept constant during health. We call these intricate arrangements by Greek and Latin names but this does not destroy the wonder and marvel to a thoughtful mind; yet to the student's mind it may. When I was in high school a fellow student said he thought there was no God. I asked him what keeps the planets from colliding and he said that is merely the law of gravitation. A single Latin synonym for "heaviness" is, in his mind, an excuse for closing up the whole matter; while Kepler works out the orbits of the planets

for the first time and exclaims, "O God I think thy thoughts after thee."

The field of the scientist is the realm of matter and energy, but surely, there are few or no scientists who teach that nothing else is real. The greatest abstract entities, such as bravery, loyalty, truth, faith, hope, and love not only are real but have far greater abiding value than wood, iron, and brass. Nor do we say that anything that has not been discovered by scientists does not exist. Yet it seems to me that our silence may infer just that to the student. A word now and then about the relation of your science to the non-material realms may help the students greatly. You have not taught your subject completely until you mention its relation to other subjects.

We need to remind ourselves frequently to differentiate between established fact and theories, deduced from the facts. This is what the best scientists are careful to do. There is perhaps no greater focal point of controversy between religion and biological science than the theory of evolution. Regardless of what our own conviction may be with respect to proof of this theory in the records of past and present life, we should recognize the fact that we have not been able experimentally to prove a progressive evolution, and thus it remains in the category of a theory.

I am sure we all agree that the best teaching will guidet sudents into personal deductions and generalizations from observation of proven facts. To that end it were better procedure to present the proven facts in biological history, and show how these facts led to the formulation of the theory of evolution. Such procedure would lead a child to formulate his own opinion regarding proven fact and theory or generalization without the jarring impact on a former philosophy about modus operandi in origin of life forms with which his spiritual life may be intimately bound up. The delicately balanced mechanism of the emotional forces of an adolescing child deserves delicate consideration from the teacher of biology, for we are dealing with forces which may build or destroy a balanced human life.

It is only fair to give the child to whom the theory is foreign an opportunity to become acquainted with the proven facts which led to the theory by extensive reading and observations, and on basis of these reject or gradually accept the theory as an explanation of the "how" of origin of life forms. Least of all should a teacher of biology resort to the unethical and heartless

treatment of ridiculing a child for an opinion held because of former teaching. Teaching of biology under direction of the scientific method will always be ethical, tactful and considerate. In the end this will prove more successful than the unscientific dogmatic "sledge hammer" procedure.

Another wholesome distinction can be made between the Bible and some of the men who theorize about it. Carefully avoid teaching in such a way that the student must choose between your teaching and the Bible. Would you discredit the Ten Commandments and the Golden Rule, on which the great democratic countries build their laws? The Bible is by no means narrow, although some of its proponents may be so, but a book which has led many to live upright lives and so it is worthy of our highest esteem and respect.

While the major part of our time is consumed in explaining how the universe is constructed, we need to counsel one another not to neglect the occasions when we either build moral fiber or tear it down. Science furnishes us the highest intellectual ideals. If we are sincerely devoted to the truth as we claim to be, we are teaching our followers to walk in the truth, and this is good ethics.

MEXICAN GEOLOGISTS TO EXPLORE HUGE PIT

Esequiel Ordonez, dean of Mexican geologists, and Ricardo Mongez Lopez, geophysicist and dean of the faculty of sciences of the National University of Mexico, will soon explore a mineral-lined pit which is believed to be over a mile deep.

Many legends surround this enormous pit, called Hell's Mouth or Devil's Pit. Tradition says that Indians used the pit to kill enemies and punish criminals. Spaniards threw prisoners into its depths. During Mexico's Independence War and the civil wars which followed, men and women were entombed in the pit.

The rumors are that gangster murders have recently been committeed in Hell's Mouth. In hunting for the body of a victim, searchers descended 1,500 feet into the pit, Cold, wind, and lack of air prevented a lower descent. From various measurements taken, it is estimated that the probable depth of the pit is 6,000 feet.

Mayor Bernabe Rios, of Tasco, has decided to close the mouth to Hell's Pit by dynamiting it or by otherwise barring access to the entrance. In this way he feels that he can remove from Tasco the notoriety connected with the pit.

Ordonez and Mongez will survey Hell's Pit with the assistance of American miners working in Tasco. If it is found that it is not of geological interest, the pit will be sealed; if, however, the survey shows the pit may have geological value, further exploration will probably be made.

It is expected that the survey will also answer the question of whether or not Hell's Pit is an entrance to the famous Cacahuamilpa Caves, located in the same region. Mineral formations clearly indicate that this pit has a similar or common origin to the caves.

AN EXPERIMENT ON THE LAW OF INERTIA

WALTER V. BURG
University of Toledo, Toledo, Ohio

It is well known that students of elementary physics frequently encounter considerable difficulties in visualizing the fact that an object which describes a circular path has the tendency to fly off on a tangent. In order to illustrate this important application of the law of inertia, the author has devised a simple experiment which can be performed with the equipment available in any physics department.

A small revolving platform is securely fastened to the demonstration table. A piece of soft wax, attached to the top of the platform near its circumference, is provided with a cavity suitable to hold a sphere about $\frac{1}{2}$ inch in diameter. A nail is driven into the underside of the platform so as to protrude approximately 2 inches. In order to support the moving sphere on its tangential path, an oblong piece of cardboard, cut to fit the circular outline of the revolving platform snugly, is mounted horizontally at the correct height. The driving mechanism consists of a string, wound around the axis of the platform and leading by way of a pulley to a small container filled with lead shot. The ring stand carrying the pulley supports a horizontal rod whose free end provides an obstruction in the circular path of the nail and, thus, serves to arrest the rotary motion of the platform at the desired instant.

In order to perform the experiment, a steel sphere about $\frac{1}{2}$ inch in diameter is placed in the cavity of the wax and the platform turned by hand until the nail touches the horizontal rod. Upon releasing, the platform describes an almost complete revolution, whereupon its movement is suddenly stopped and the sphere projected in a tangential direction.

The quantity of lead shot, necessary to produce the desired motion of the platform, must be determined by trial. While too high an angular velocity will cause the sphere to fly off prematurely, too slow a rotation will not bring about a satisfactory projection. If the weight of the shot has been adjusted correctly, the experiment, which consumes only a fraction of a minute, can be reproduced easily.

Knowledge is the material with which genius builds her fabrics.

THE WINNERS—SCIENCE TALENT SEARCH 1942

SISTER M. AMBROSIA, I.H.M.
Marygrove College, Detroit, Michigan

Many readers of SCHOOL SCIENCE AND MATHEMATICS have undoubtedly followed the results of the annual Science Talent Search instituted by Science Service in 1942. The contests, which are made possible by the financial assistance of Westinghouse Electric and Manufacturing Co., are open to any twelfth grade boy or girl in any parochial, private or public school in continental United States, who at graduation is able to fulfill college entrance requirements.

The Search uses the successive hurdle procedure for selecting the winners. The contestants who make the first hurdle are eligible for consideration in the second, and so on until all the hurdles have been crossed. The six hurdles which are used are:

1. Science aptitude examination
2. Score on high school record and rank in graduating class
3. Score on teacher recommendations
4. Rating on essay submitted
5. Rating on standardized personal interview
6. Rating on social attitudes test

In the first Search (1942) 300 students survived the second hurdle and 40 students, the fourth. The latter were awarded an all-expense-paid trip to Washington, D. C. The other 260 survivors of the second hurdle were awarded honorable mention. The fifth and sixth hurdles were used to select from the trip winners the recipients of twenty scholarship awards, two four-year scholarships and eighteen part-time scholarships.

The committee of judges is selected by Science Service. Each scholarship may be applied toward a degree in science or engineering. The winner may select the institution of higher learning at which he wishes to study. The institution, however, must be approved by the scholarship committee chosen by Science Service.

Is this Search for Science Talent another evidence that the American system of education is not producing satisfactory results or is it a sign that American youth is hiding its light under a bushel? Ordinarily, a search is prompted by a desire to recover a lost good or to gain a coveted one. Caught in the clutches of a scientific war, our government is coveting scientific talent. By

trying to discover boys and girls who have given their scientific talents a chance, Science Service is encouraging the reform necessary to raise the American system of education from the state in which the Army and Navy have found it. Any work which will stimulate the development of the mind power of American man power is worthy of the title "Service."

Since the successful contestants of the first search had gone through high school unaware that they were going to be sought as formally as they were, we felt that a study of them might prove informative to mathematics and science teachers. Questionnaires were sent to the three hundred students who were awarded scholarships, the Washington trip or honorable mention in 1942. The data recorded in the study are taken from the one hundred sixty-five replies received.

TABLE I

Science Background	*Percentage Distribution*
General Science	71
Biology	66
Chemistry	98
Physics	91
An additional Science (Astronomy, Physiology, etc.	12

Table I shows that more than ninety per cent of the group had studied physics. It shows also that one-third of the group achieved high on this aptitude test without having studied biology. The contrast in these percentages is noteworthy because these boys and girls were in high school when physics was studied by relatively few and biology was popular.

The science aptitude examination used in the search consisted of eighteen paragraphs, each followed by questions which could be answered on the basis of material given in the paragraphs. The content of the paragraphs was facts from the sciences: geology, physics, chemistry, physiology, mathematics, agriculture and psychology. As teachers, we are interested in knowing why these particular individuals achieved higher than some 2,800 other contestants. The actual answer to the question may never be known, but two possible answers may be suggested: either the high school training of these contestants had developed their reasoning power or there was a mechanical memory carry-over from their class work in high school. Without taking into account the I.Q. scores and reading ability of the contestants, factors which enter into the total picture, there would seem to be some warrant for the assumption that reasoning

power rather than memory was responsible for their achievement. More than ninety per cent of them had studied chemistry and physics, sciences which are called difficult because one has to be able to reason in order to pass them. One-third of the group had not studied biology. Memory could not have helped this one-third when they came to the paragraphs concerning physiology, psychology and certain phases of geology and agriculture.

TABLE II

UNITS OF SCIENCE LISTED IN TABLE I TAKEN BY EACH CONTESTANT

Units	Per cent of group
One	1.8
Two	15.7
Two and one-half	.6
Three	35.7
Three and one-half	.6
Four	45.4

In all the cases in which only one science had been studied, the science was chemistry. Physics and chemistry made up 61% of the two science combinations. The three science groupings were general science, chemistry and physics for 52% of the cases and biology, chemistry and physics for 40.8%.

The questionnaire asked also for the year in which each science had been studied. The answers to this question showed nothing particularly noteworthy except that physics and chemistry were distributed rather evenly between junior and senior years: chemistry, 47% in junior year, 45% in senior year; physics, 39% in junior year, 49% in senior year.

TABLE III

THIS TABLE SHOWS THE VARIOUS COMBINATIONS OF UNITS IN MATHEMATICS IN SCIENCE

Units in Science	*Units in Mathematics*										
	1/2	1	3/2	2	5/2	3	7/2	4	9/2	5	*Total Contestants*
1/2											
1						1	1	1			3
3/2											
2					1	6	6	8	4	1	26
5/2						1					1
3				3	1	8	8	25	12	2	59
7/2									1		1
4				5	2	13	13	32	10		75
Total contestants				8	4	29	28	66	27	3	165

TABLE IV

Units in Mathematics

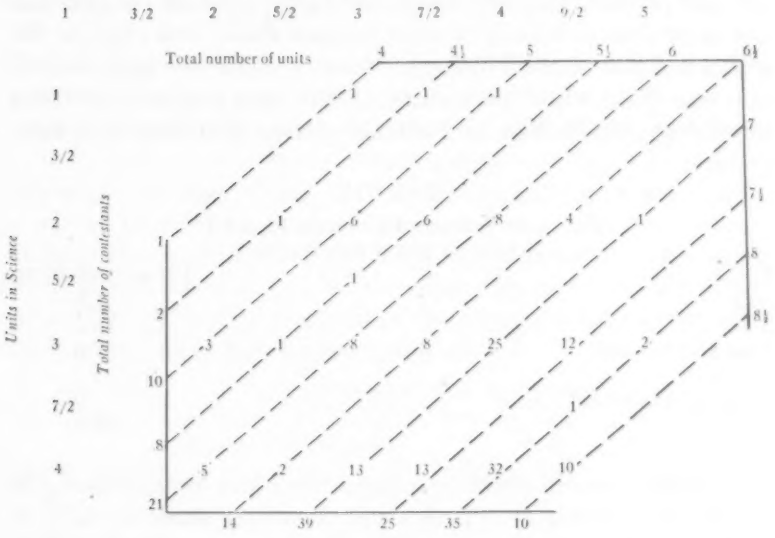

Total number of units
Units in Science
Total number of constants
1 3/2 2 5/2 3 7/2 4 9/2 5
4 4½ 5 5½ 6 6½
1 3/2 2 5/2 3 7/2 4
7 7½ 8 8½
1 2 10 8 21
14 39 25 35 10

Table IV is Table III with totals taken on the diagonals. Assuming that fifteen is the number of units required for graduation, 27.2% of this group had earned more than half that number in mathematics and science. One might expect this percentage to be higher than it is. The fact that it is low is a good thing and may indicate that the other five selection procedures were really helpful in pointing out the better prospective college student, one whose secondary education had not been too one-sided. It is more than probable that a great many of these boys and girls achieved as high ratings in other subjects as in science. Their science training, however, would be their best immediate preparation for the test.

TABLE V

Group Distribution According to Home Town Population

Population	*Percent*
below 10,000	28.5
11,000–20,000	13.0
21,000–70,000	11.8
71,000–300,000	14.9
301,000–1,500,000	14.9
1,500,000–	16.7

If talent is what this search really found, Tables V and VI show that almost half of it was brought to light in moderate

TABLE VI

Group Distribution According to High School Enrollment

Enrollment	*Percent*
below 1,000	42.5
1,100–2,000	29.6
2,100–3,000	15.4
3,000–	12.2

sized towns and high schools. Our data also show that 47.9% of it came from homes in which neither parent was a college graduate. In 18.6% of the cases both parents were college graduates.

The data on the father's occupation were so heterogeneous that it was impossible to assemble them. We do know, however, that if the proud fathers could have celebrated with an afternoon at baseball, the salesmen could have played the teachers; there would have been a newspaper man and a photographer to cover the game and a physician and a dentist to care for the casualties. A cheer from the stand might have come from a lawyer, a boilermaker, an admiral in the Navy, a farmer, a druggist, a painter or a research chemist.

Previous to 1942 these potential scientists were living in typical American homes and attending average American high schools. Some of them had not had an extraordinary amount of class work in science. The fact that so many of them had studied physics and chemistry would indicate that all of them must have had a very great interest in science. What their further achievement will be, the annual ten-year follow-up will show.

GRANT OF $75,000 MADE FOR COLLECTING AND MAKING AVAILABLE CURRENT INFORMATION ON WAR MEDICINE

A grant of $75,000 has been made for collecting up-to-the-minute information on war medicine and making it available to members of the medical profession. The money is provided by the Johnson and Johnson Research Foundation to the National Academy of Sciences and the National Research Council.

This grant is made to help overcome one of the greatest difficulties in medicine today, that of providing adequate current information to the medical officers of the armed services both in this country and abroad, and of making the experiences of war medicine available to civilian physicians.

The project will be administered by the Division of Medical Sciences of the National Research Council, under the chairmanship of Dr. Lewis H. Weed. Various medical reports, both civilian and military, from all parts of the world will be culled for pertinent information. Bulletins containing current advances in medical practices and medical research which are not military secrets will be issued. Studies which cannot be released now will be carefully held for later release.

EXPLORING THE CAREERS IN THE BIOLOGICAL SCIENCES

GLADYS M. RELYEA
447 Midland Street, Bridgeport, Connecticut

Most of the students in high schools and colleges seem to have the idea that careers in the biological sciences are limited to teaching, medicine, and research. At least, that has been my impression. And the reason that this is so, I believe, lies in the fact that up-to-date descriptions of the more than fifty biological science occupations have not been made easily available, first, to teachers and counselors, and second, to interested students.

Because all levels of occupations are represented in this field, every boy and girl who has evidenced a special liking for biology can find a suitable career, whatever his intelligence, economic status, or educational history. Dairy helpers, fishermen, kennelmen, and laboratory helpers represent the semi-skilled level; dairy foremen, laboratory technicians, kennel owner, government fish culturist represent the skilled level; forester, farmer, nature photographer, horticulturist, the semi-professions; and college professor, museum curator, veterinarian, physician, research worker, the professions.

It is the purpose of the list which follows to provide suggestions for books which will present a true picture of occupations at these three levels. The books included are of two kinds: 1, studies of particular occupations from the point of view of requirements in ability, training, education; advantages and disadvantages of the occupation; present status; as, for example, *Careers in Forestry*, and *Photographic Occupations*. 2, detailed descriptions of an occupation and practical information as to how to make a success of it, as, *How to Raise Mink, New England's Fishing Industry, Nut-Growers' Handbook*, from which the reader must draw his own conclusions as to its value as an occupation for him.

With but few exceptions, the books which follow were published (new or revised editions) since 1935. The exceptions are books which represent occupations for which no recent book could be found. Books starred have been annotated by this writer. Those unstarred have been recommended by such authorities as *Occupations Index, Nature Magazine, Peabody Journal of Education, Standard Catalogue for High School Libraries*.

HUNTING AND FISHING

*Ackerman, E. A., New England's Fishing Industry
University of Chicago Press, Chicago, 1941
Detailed analysis of the industry, jobs told about rather incidentally. Photographs.

Luard, L., Conquering Seas
N. Y., Longman's, 1935
"Problems of modern fishing industry and how radio aids the fleet."

Meader, S. W., Traplines North
N. Y., Dodd Mead, 1936
"True picture of life in the northern wilderness that will appeal to boys looking for an outdoor occupation."

Williamson, T. R., Lobster War
N. Y., Lothrop, 1935
"Lobster fishing as an occupation, in story form."

ART IN THE BIOLOGICAL SCIENCES

*Leyson, Capt. Burr, Photographic Occupations
N. Y., Dutton, 1940
Chapter 8—Medical and Surgical Photography
Chapter 17—Pictorial Photography
Chapter 20—Nature Study Photography

Ridgway, John L., Scientific Illustration
Stanford University Press, 1941
"Making illustrations for scientific publications has become a splendid and most interesting profession in our times, to be suggested for serious consideration by those with artistic ability." "This handsome volume is not intended for beginners or as a manual of instruction on learning to draw; rather it is for those who have already mastered at least the fundamentals of artistic technique and who may wish to apply their knowledge and skill to a specialized field."

RAISING AND CARING FOR NON-FARM ANIMALS

*Adams, L. H., Mink raising
Columbus, Ohio, Harding Publishing Co., 1935
Gives practical information on how to raise, feed, and sell marten, fisher, and mink.

*Bridges, Wm., Big Zoo
N. Y., Viking Press, 1941
Photographs by Desider Holisher and well-written and factual text. Gives good idea of the work to be done in a city zoo.

*Edwards, J. L., Raccoon Raising
Utica, N. Y., Fur Farms Publ. Co., 1929
Pamphlet on raising, caring for, and selling raccoons.

*Edwards, J. L., Muskrat Farming
Utica, N. Y., Fur Farms Pub. Co., 1928
Pamphlet on raising, skinning, caring for, selling, etc.

*Elliott, C. N., Careers in Wildlife Management
Chicago, Science Research Associates, 1940
Workers, types of work, training, abilities needed, pay, etc.

*Foster, J. C., Twentieth Century Dog Breeding
San Antonio, Texas, Naylor Co., 1939
Breeder's job, tools and materials, inheritance, program, selecting parents; special attention to American Pointer.

*Glick, C. B., Parrakeet Breeding for Profit
Author, 1933
Breeding, housing, feeding and care, of parrakeets, cockatoos, lovebirds, finches. Pamphlet.
*More Game Birds in America Assn., Pheasant Breeding Manual
More Game Birds in America, 500 Fifth Ave., N. Y., 1938.
Pamphlet on how to raise pheasants.
*Naether, Carl A., The Book of the Pigeon
Phila., David McKay Publ., 1939
Excellent book on history, breeding, care, breeds, etc.

RAISING AND CARING FOR FARM ANIMALS

*Coffey, J. S. and Jackson, L. E., Livestock Management
N. Y., Lippincott, 1940
Factual descriptions of the various types of livestock enterprises—dairy farming, beef-cattle production, hog raising, sheep raising, horses on the farm, farm poultry flock. Discussions of marketing livestock, breeding and care of livestock. Photographs.
N. Y. A. for Kentucky, The Horse Industry
Louisville, Ky., 1939
Information about horses and their breeding; also gives information about types of workers needed, and their qualifications.
*Root, Amos J., The ABC and XYZ of Bee Culture
Medina, Ohio, Root Company, 1940
Very good presentation of practically everything pertaining to bee culture.
*Tewalt, W. L., Improved Milk Goats
N. Y., Orange Judd Publ. Co., 1942
History of milk goats, then various breeds. How to start business, selling, exhibiting, etc. Photographs.

RAISING AND CARING FOR PLANTS

a. Growing of Various Crops

*Bush, C. D., Nut Growers Handbook
N. Y., Orange Judd Publ. Co., 1941
Practical guide to propagation, planting, cultivation, harvesting, marketing, of chestnuts, filberts, walnuts, pecan, hickories, almond, pine nuts, chinquapins, etc.
Clemens, N., Under Glass
N. Y., Longmans, 1937
"Rehabilitation of rundown greenhouse—various problems of growing things under glass. Flower business in detail."
*Davis, K. C., Horticulture Enterprises
N. Y., Lippincott, 1939
Considers fruit, vegetable, woodland crops, and tells how and what to plant; marketing. Very practical advice and instructions. Photographs.
*Rettew, Gohm, and Divine, Manual of Mushroom Culture
West Chester, Penna., Chester Co. Mushroom Labs, 1941
Complete guide to growing, diseases and pests, spawn production, marketing, of commercial mushrooms, Photographs.
*Wagner, P. M., Wine Grapes; Their Selection, Cultivation, Enjoyment
N. Y., Harcourt Brace, 1937.
How to grow several varieties of grapes, soil preparation, pruning, diseases, etc. Practical for any state.

*Wernicke, G. W., Jobs in Horticulture
Chicago, Science Research Associates, 1940
Pomology, Olericulture, Floriculture, Landscaping are all considered as to advantages and disadvantages, requirements for workers, status of job.

b. Forestry

*Elliott, C. N., Careers in Forestry
Chicago, Science Research Associates, 1940
Careers at various levels in forestry, each discussed as to work included, requirements for workers, future of each.
*Illick, J. S., Outline of General Forestry
N. Y., Barnes and Noble, 1939
Excellent overview of forestry and its branches; types of jobs, requirements of workers. Photographs.
Sherman, E. A., Forestry as a Profession
U. S. Forestry Service, Washington, 1936
U. S. Dept. of Agriculture, Careers in Forestry
Govt. Printing Office, Washington, 1939

FARMING IN GENERAL

*Chapman, P. W., Opportunities in Farming
Chicago, Science Research Associates, 1940
Farm occupations; work in each, income, training needed, getting started, etc.
*Chapman, P. W., Jobs in Rural Service
Chicago, Science Research Associates, 1940
Agricultural education workers, scientists and technicians, industriaial and commercial opportunities, regulatory service employees, professional fields in agriculture; all these described as to workers needed, their training, their opportunities.
Davidson, Dora, Friend to Farm Women
N. Y., National Federation of Business and Professional Women's Clubs, 1941
The Home Demonstration Agent and her work.
Virginia Polytechnic Institute, Opportunities in Agriculture
Blacksburg, Va., Bulletin 6, 1941
"Nineteen chapters, each on a particular branch of agriculture; kinds of work, workers needed, working conditions, etc."

MEDICINE AND DENTISTRY

a. Medicine

Anderson, Dwight, What It Means to be a Doctor
N. Y., Medical Society for the State of N. Y., 1939
"A study of the character and skills required for a successful practice of medicine."
Fishbein, Morris, Do You Want To Become a Doctor?
N. Y., Stokes, 1939
"Wise advice as to preparation, long training, and early practice."
*Klinefelter, L. M., Medical Occupations for Boys
N. Y., Dutton, 1938
Chapters on physician, medical specialist, medical technologist, physical therapy technician, occupational therapist, x-ray technician, chiropodist, dentist, dental technician, government medical service, nurse, optometrist, pharmacist, veterinarian. Photographs, story form.

*Klinefelter, L. M., Women in White; Medical Occupations for Girls
N. Y., Dutton, 1939
Chapters on physician, medical specialist, dentist, chiropodist, dental hygienist, dietitian, laboratory technician, nurse, occupational therapist, optometrist, pharmacist, physical therapist, x-ray technician. Photographs, story form.

*Wilson, N., and Weisman, S. A., Modern Medicine; its Progress and Opportunities
N. Y., Stewart Publ. Co., 1942
Various branches; description of each, vocational opportunities in each.

b. Nursing

*Brown, E. L., Nursing as a Profession
N. Y., Russell Sage Foundation, 1940
Includes preparation for nursing, national organizations, demand and supply, salaries, status of nursing, etc.

*Schulz, Cecelia, Your Career in Nursing
N. Y., Whittlesey House, 1941
Chapters on what nursing takes, nursing schools, the making of a nurse, nurses at work, preface to nursing.

*Sutherland, D., Do You Want to Be a Nurse?
N. Y., Doubleday Doran, 1942
Very good, light-style description of nursing as a career. Chapters on these topics: Why Nursing? Behind the scenes. Backbone of the Profession. Selling Health. About Specialties. Nurses at War. (and others)

Wales, Marguerite, Public Health Nurse in Action
N. Y., Macmillan, 1941
"Ten avenues of her work, as orthopedics, industrial, tuberculosis, etc."

c. Specialties

American Society of Clinical Pathologists, The Registry of Medical Technologists
Denver, Colo., 1939
Requirements for registration in this national organization.

Greenleaf, W. J., Pharmacy
Washington, D. C., Govt. Prtg. Office, Guidance Leaflet #14, 1941

Woodhouse, C. G., Dental Careers
N. Y., Funk and Wagnalls, 1939
"A careful analysis written for young people, of vocational opportunities in dentistry and dental hygiene."

TEACHING AND RESEARCH

Allee, M. H., Great Tradition
N. Y., Houghton Mifflin, 1937
"Story of group of girls doing graduate research in biology."

*Donovan, F. R., The Schoolma'am
N. Y., Stokes, 1938
Complete picture of training, jobs, salary, number, character traits, dangers, etc. of schooltacher. No special attention to biology teacher.

*Houle, C., Teaching as a Career
Chicago, Science Research Associates, 1940
Good outline of the career of the teacher, not especially the biology teacher, but helpful nevertheless.

Mallette, G., Single Stones
N. Y., Doubleday Doran, 1940

"Inspirational novel about young woman medical student who works hard and completes an important research."

*Yates, L. F., Science Calls to Youth
N. Y., Appleton-Century, 1941
Not much factual vocational information, but valuable nevertheless for the young student who plans on research in science.

GENERAL REFERENCES WITH SECTIONS ON CAREERS IN THE BIOLOGICAL SCIENCES

*Brewer, J. M., Occupations
N. Y., Ginn, 1936
Chapter 14—Homemaking and Other Personal and Domestic Occupations—homemaker, farmer's wife, nurse, dietitian, home economist
Chapter 15—Agriculture—General farmer, women as farmers, stockraiser, dairyman, fruitgrower, florist, nurseryman, beekeeper, seedsman, research work, teaching, county agriculture agent, 4H Club work, farm manager, forester, fisherman, etc.
Chapter 16—Scientific Professions—Sanitary engineer, industrial chemist in paper, textile, rubber, et. Physician, psychiatrist, dentist.
Chapter 18—Other Professional Workers—assistants to physician, dentist, surgeon. Medical secretary, optometrist, pharmacist, laboratory assistant, laboratory technician.

*Carlisle, N., and McFerran, D., Civil Service Careers for Girls
N. Y., Dutton, 1941
In story form, gives opportunities and work of doctors, nurses, scientists, farm researchers, etc., as well as non-science civil service careers in various government departments.

*Carlisle, N., and Erickson, C., Civil Service Careers for Boys
N. Y., Dutton, 1941
In story form, as above, giving opportunities in civil service careers in science as part of the total civil service opportunities for men workers.

*Chapman, P. W., Occupational Guidance
Atlanta, Turner Smith, 1937
Chapter 4—The Business of Farming
Chapter 5—Careers through Agricultural Training
Chapter 6—Forestry
Chapter 7—Occupations in Homemaking
Chapter 26—Professions

Faust, J. F., The Girl's Place in Life and How to Find It
Urbana, Ill., McDonnell Co., 1942
Written for girls' classes in vocational guidance. Chapters on teaching, library and museum service, medicine, health services.

*Filene, C., Careers for Women
N. Y., Houghton Mifflin, 1934
Each of the following vocations is described by a woman successful in it: Dairy Farmer, Stockfarm Manager, Horticulturist, Supervisor of Home Gardens, Explorer, Ornithologist, Scientific Artist, Taxidermist, Teacher, City Sanitarian, Clinical Director, Clinical Psychologist, Dentist, Dietitian, Nurse, Nutritionist, Woman Surgeon, Museum Librarian, Museum Director, Anthropologist, Archeologist, Geographer, Medical Secretary, Mycologist, Pharmacist, Sea Diver.

*Fleishman, D. E., An Outline of Careers for Women
N. Y., Doubleday Doran, 1935
Short chapters, each written by a woman successful in the occupation: agriculture, child welfare, dietetics, education, journalist, manufacture of food products, medicine, nursing, science, stock breeding, etc.

*Hoerle, H., The Girl and Her Future
N. Y., Smith and Hoas, 1935
A section on the professional woman discusses the chemist, dentist, dietitian, geologist, home economist, laboratory technician, librarian, museum worker, nurse, pharmacist, physician, taxidermist, teacher. A section on the woman in government employ lists chemist, pathologist, botanist, home economist, nematologist, entomologist, zoologist, bacteriologist, horticulturist.

*Kitson and Lingenfelter, Vocations for Boys
N. Y., Harcourt Brace, 1942
Includes careers in the biological sciences.

*Lingenfelter and Kitson, Vocations for Girls
N. Y., Harcourt Brace, 1939
Chapters on Nursing, Home Economics, Teaching, Social Service, Library Work, Dental Hygiene, Agriculture, Recreation Work, Physiotherapy, Osteopathy, Optometry, Government Service, Medicine, Dentistry, Science.

*Lockhart, E. G., My Vocation
N. Y., H. W. Wilson, 1938
Short chapters, each by an eminent success in the vocation: Agriculture, Dentistry, Home Making, Journalism, Librarianship, Medicine, Nursing, Physical Education, Teaching.

Lehigh University, Biology as a Career
Bethlehem, Penna., Lehigh University, 1939
Short pamphlet giving vocational opportunities in health work, conservation, teaching, manufacturing, etc., for those with training in biology.

*Myers, Little, and Robinson, Planning Your Future
N. Y., McGraw-Hill, 1940
Chapter 7—Agricultural Occupations
Chapter 8—Forestry and Fishing Occupations
Chapter 14—Professional Service Occupations

*Science Research Associates, Occupational Outlines on America's Major Occupations, Chicago, 1940
Several pages on each of the following science fields: college professors, dentists, drugstore workers, cattle farming, dairy farming, fruit farming, general farming, truck farming, fishermen and oystermen, lumbermen, trained nurses, practical nurses, photographers, physician and surgeon, teachers.

Shade, Chloris, Biological Work
Success Vocational Information Series, 1940, #41
In this same series is included pamphlet 16 on Florist Industry, #53 on Dairying, #37 on Medicine, #40 on Nursing, #54 on Market Gardening.

*Waltz, G. H., What do you want to be?
N. Y., Holt and Co., 1939
Careers for boys, lightly written but factual. Some photos. Chapter 3, Doctor; Chapter 7, Writing for a Living; Chapter 8, Camera Careers; Chapter 10, Exploring as a job; Chapter 12, Farming and Forestry; Chapter 13, Careers in Government; Chapter 14, Teaching.

*Williamson, E. G., Students and Occupations
N. Y., Holt and Co., 1937
Entire book excellent for college student, especially. Chapter 4, Medical Occupations; Chapter 7, Agriculture; Chapter 8, Forestry; Chapter 9, Home Economics; Chapter 10, Teaching; Chapter 13, Journalism and Writing; Chapter 14, Social Welfare Occupations.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interst anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1831. *Proposed by Arthur B. Hussey, New Rochelle, N. Y.*

Mrs. Allen, Bates, and Clark, and their three daughters bought cloth and lace. Each paid as many cents per yard as she bought yards. Each lady paid 63¢ more than her daughter. Jane bought 23 yards less than Mrs. Allen; Eliza bought 11 yards less than Mrs. Bates. The other daughter was named Ann. What was the full name of each girl?

Solution by the Proposer

Let m_1, m_2, m_3 be the number of yards bought by the mothers; with payments of m_1^2, m_2^2, m_3^2 cents. Let d_1, d_2, d_3 be the number of yards bought by their daughters respectively; with payments therefore of d_1^2, d_2^2, d_3^2 cents.

For any mother and her daughter (for any value of subscripts)

$$m^2-d^2=63;$$

$$(m-d)(m+d)=63=9\times 7 \text{ or } 21\times 3 \text{ or } 63\times 1.$$

$$m_1-d_1=7,\ m_1+d_1=9,\ \therefore\ m_1=8,\ d_1=1;$$

$$m_2-d_2=3,\ m_2+d_2=21,\quad m_2=12,\ d_2=9;$$

$$m_3-d_3=1,\ m_3+d_3=63,\quad m_3=32,\ d_3=31.$$

Inspection for the differences 23 and 11 shows

$$m_3-d_2=23,$$

hence Mrs. Allen bought

$$m_3=32 \text{ yards},$$

and Jane bought

$$d_2=9 \text{ yards}; \quad m_2-d_1=11$$

hence Mrs. Bates bought

$$m_2=12 \text{ yards},$$

and Eliza bought

$$d_1=1 \text{ yar};$$

leaving Mrs. Clark to buy m_1 yards and Ann d_3 yards.

The names are therefore Ann Allen, Jane Bates, Eliza Clark.

Solutions were also offered by Helen M. Scott, Baltimore, Md.; W. R. Smith, Suttons Bay, Mich.; W. A. Richards, Berwyn, Ill.; M. Kirk, West Chester, Pa.; Harvey Rubinstein, Brooklyn, N. Y., and Hugo Brandt, Chicago.

1832. *Proposed by Walter R. Warne, Rochester, N. Y.*

Resolve into three factors each of second degree in α, β, γ, the expression

$$(\alpha+\beta+\gamma)^3\alpha\beta\gamma-(\alpha\beta+\alpha\gamma+\beta\gamma)^3.$$

Solution by William A. Richards, Berwyn, Ill.

$$\begin{aligned}
&(\alpha+\beta+\gamma)^3\alpha\beta\gamma-(\alpha\beta+\alpha\gamma+\beta\gamma)^3\\
&=\alpha^3\beta^2\gamma^2-\alpha^2\gamma^3-\beta^2\gamma^3+\alpha\beta\gamma^4-\alpha^3\beta+\alpha^4\beta\gamma+\alpha\beta^4\gamma-\alpha^3\beta^2\gamma^2\\
&=\alpha^2\gamma^2(\beta^2-\alpha\gamma)-\beta\gamma^3(\beta^2-\alpha\gamma)-\alpha^3\beta(\beta^2-\alpha\gamma)+\alpha\beta^2\gamma(\beta^2-\alpha\gamma)\\
&=(\alpha^2\gamma^2-\beta\gamma^3-\alpha^3\beta+\alpha\beta^2\gamma)(\beta^2-\alpha\gamma)\\
&=(\alpha^2-\beta\gamma)(\beta^2-\alpha\gamma)(\gamma^2-\alpha\beta).
\end{aligned}$$

Solutions were also offered by Harvey Rubinstein, Brooklyn, N. Y.; Hugo Brandt, Chicago, William Funkenbusch, Canton, Mo., and M. Kirk, West Chester, Pa.

1833. *Proposed by William Meddick, Los Angeles, Calif.*

If y is positive, show that $\log y$ lies between

$$\frac{2(y-1)}{(y+1)} \quad \text{and} \quad \frac{y^2-1}{y}.$$

Solution by Hugo Brandt, Chicago

Let

$$f_0=\ln y, \quad f_1=\frac{2(y-1)}{y+1} \quad \text{and} \quad f_2=y-\frac{1}{y}.$$

Since for $y=1$, $f_0=f_1=f_2$, the proposition for $y=1$ may be considered true.

Now

$$f_1'=\frac{4}{(y+1)^2} \quad \text{and} \quad f_2'=1+\frac{1}{y^2}.$$

At $y=1$, the slope $f_2'>f_1'$. It is also true for any other positive y. Thus when $y\to\infty$, $f_1'\to 0$ and $f_2'\to 1$ and for $y\to 0$, $f_1'\to 4$ and $f_2'\to\infty$.

Now it remains to show that $f_2'>f_0'>f_1'$, a sufficient condition for having f_0 between f_1 and f_2, since the three f's have a point in common.

Now

$$f_0'=\frac{1}{y} \quad \text{and} \quad f_2'=1+\frac{1}{y^2},$$

hence $f_2' > f_0'$. Also

$$f_0' = \frac{1}{y} \quad \text{and} \quad f_1' = \frac{4}{(y+1)^2}$$

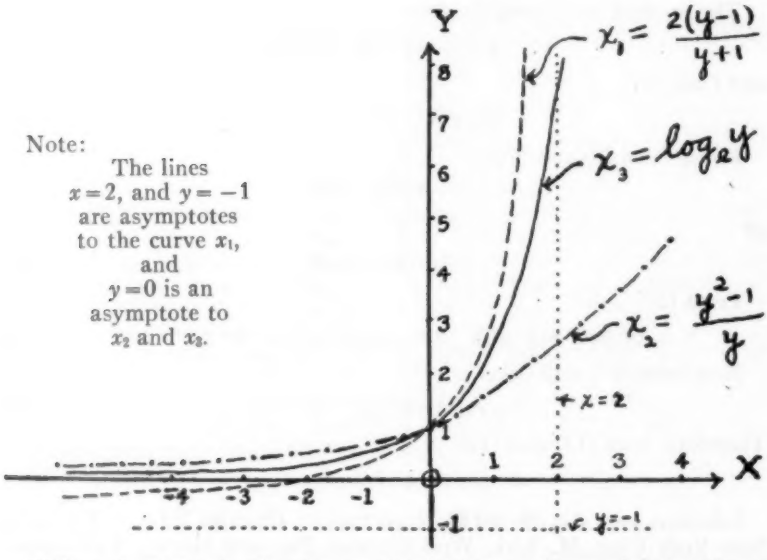
and except for $y = 1$,

$$\frac{1}{y} > \frac{4}{(y+1)^2}.$$

Thus

$$f_0' > \frac{4}{(y+1)^2}.$$

Hence $f_2' > f_0' > f_1'$ and also f_0 lies between f_2 and f_1.



Note:
The lines $x = 2$, and $y = -1$ are asymptotes to the curve x_1, and $y = 0$ is an asymptote to x_2 and x_3.

William A. Richards offered a graphical solution, the graph being given. Aaron Buchman also offered a solution.

1834. *Proposed by Phillip S. Perkins, Camden, N. J.*

Given:

$$x+y+z=1 \tag{1}$$

$$x^2+y^2+z^2=2 \tag{2}$$

$$x^3+y^3+z^3=3 \tag{3}$$

Prove:

$$x^4+y^4+z^4=4\tfrac{1}{6} \tag{4}$$

Solution by William A. Richards, Berwyn, Ill.

Square (1), subtract (2) and divide the difference by 2. This gives

$$xy+xz+yz=-\tfrac{1}{2} \tag{5}$$

From (2)

$$(x+y)^2=2+2xy+z^2$$

and from (1)

$$(x+y)^2=1-2z+z^2$$

Hence

$$2+2xy-z^2=1-2z+z^2, \quad \text{or} \quad xy=z^2-z-\tfrac{1}{2} \tag{6}$$

Then from (2) and (6)

$$x^2-xy+y^2=2\tfrac{1}{2}+z-5z^2 \tag{7}$$

and from (1)

$$x+y=1-z \tag{8}$$

The product of (7) and (8) gives

$$x^3+y^3=2\tfrac{1}{2}-1\tfrac{1}{2}z-3z^2+2z \tag{9}$$

and from (3)

$$x^3+y^3=3-z^3 \tag{10}$$

Hence from (9) and (10)

$$z^3-z^2-\tfrac{1}{2}z-\tfrac{1}{6}=0,$$

or

$$4z^3-4z^2-2z=\tfrac{2}{3} \tag{11}$$

From (2)

$$(x^2+y^2)^2=(2-z^2)^2, \quad \text{or} \quad x^4+y^4+z^4=4-4z^2+2z^4-2x^2y^2 \tag{12}$$

Now from (12) and (6)

$$x^4+y^4+z^4=4z^3-4z^2-2z+7/2 \tag{13}$$

Therefore, from (13) and (11)

$$x^4+y^4+z^4=\tfrac{2}{3}+7/2=4\tfrac{1}{6}.$$

Solutions were also offered by Hugo Brandt, Chicago, P.f.c. A. Kramish, New York City, M. Kirk, West Chester, Pa., and Harvey Rubinstein, Brooklyn, N. Y.

1835. *Proposed by Hugo Brandt, Chicago, Ill.*

If a hen and a half lays an egg and a half in a day and a half, how many hens lay how many eggs in the smallest (integer) number of days if the sum of the hens, eggs and days is 100?

Solution by M. Kirk, West Chester, Pa.

Let h, e, d be the number of hens, eggs and days respectively. Then

$$h+e+d=100.$$

Since 3 hens lay 2 eggs in 1 day, h hens lay $\frac{2}{3}hd$ eggs in d days or

$$\tfrac{2}{3}hd=e.$$

For

$$d=2 \qquad e=\frac{4}{3}h$$

and

$$h+\frac{4}{3}h+2=100$$

which gives

$$7h=294.$$

Hence

$$h=42, \qquad e=56.$$

Thus 42 hens lay 56 eggs in 2 days.

Solutions were also offered by W. A. Richards, Berwyn, Ill.; W. R. Smith, Suttons Bay, Mich.; Joseph M. Synnerdahl, Chicago; Helen M. Scott, Baltimore, Md., and the proposer.

1836. *Proposed by Myrtie Hyatt, Newburg, N. Y.*

The difference of the squares of any two odd integers is divisible by 8.

Solution by Walter H. Carnahan, Purdue University

Let $2h+1$ be one of the numbers and $2k+1$ be the other.

Then,

$$\begin{aligned}&(2h+1)^2-(2k+1)^2\\&=4h^2+4h+1-4k^2-4k-4\\&=4(h+k)(h-k)+4(h-k)\\&=4(h-k)(h+k+1).\end{aligned}$$

If h and k are both odd or both even, then $h-k$ is even. If either h or k is even and the other odd, then $h+k+1$ is even. In all cases, one of the factors is an even number, say $2p$. The final form derived above is then either $4\times 2p(h-k)$ or $4\times 2p(h+k+1)$, that is, $8p(h-k)$ or $8p(h+k+1)$. In either case it is divisible by 8.

Solutions were also offered by W. R. Smith, Suttons Bay, Mich.; Hugo Brandt, Chicago; Wayne Cowell, Manhattan, Kan.; M. Kirk, West Chester, Pa.; Alan Wayne, Flushing, N. Y.; D. F. Wallace, St. Paul, Minn.; Harvey Rubinstein, Brooklyn, N. Y.; Wm. A. Richards, Berwyn, Ill., and Joseph M. Synnerdahl, Chicago.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

1836. Murray Lerner, Boys High School, Brooklyn, N. Y. and Madlyn Bertram, Hannibal, Mo.; Sheldon Kert, Toronto, Canada.

PROBLEMS FOR SOLUTION

1849. *Proposed by Hugo Brandt, Chicago, Illinois.*

In an isosceles triangle the sum of the tangents of the three angles equals $(-\frac{1}{3})$; if its area is expressed by the same number of square units as the number of linear units in its perimeter, what is that number?

1850. *Proposed by Harvey Rubenstein, Brooklyn, New York.*

On the sides AB and AC of a triangle ABC, construct on the outside of the triangle squares $ABEF$ and $ACGD$ respectively. Draw DF. If AJ is perpendicular to BC at J, then AJ bisects DF.

1851. *Proposed by Norman Anning, University of Michigan.*

It is given that

$$a=1.58489, \quad \log a=0.2$$
$$b=2.51189, \quad \log b=0.4$$
$$c=3.98107, \quad \log c=0.6$$
$$d=6.30957, \quad \log d=0.8$$

Use this table and gumption to show that

$$\frac{a^2+b^2-c^2}{2ab}=\frac{d^2+10a-10c}{20}=-0.88261.$$

1852. *Proposed by a Reader.*

In a triangle if $a^2=b(b+c)$ prove that $A=2B$, a, b, c, being sides, with A, B, C, the angles opposite respectively.

1853. *Proposed by Leslie Smith, Hale, Missouri.*

The sides of a triangle are 27, 28, 35. Prove that one angle is exactly three times another.

1854. *Proposed by James Holbrook, Shaqualak, Miss.*

A stone starting from rest slides down a roof sloping 30° to the horizontal, thru a distance of 12 ft. If the lower edge of the roof is 50 feet high when, where and with what velocity does the stone strike the ground?

BOOKS AND PAMPHLETS RECEIVED

A TREASURY OF SCIENCE, by Harlow Shapley, *Director of the Harvard College Observatory*, and Samuel Rapport and Helen Wright, both *Members of the Staff of Harper and Brothers*. Cloth. Pages xi+716. 14.5×21.5 cm. 1943. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $3.95.

BASIC RADIO PRINCIPLES, by Maurice Grayle Suffern, *Captain, Signal Corps, Army of the United States*. Cloth. Pages x+271. 13.5×20.5 cm. 1943. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.25.

ANALYTIC GEOMETRY, by Frederick H. Steen, Ph.D., *Associate Professor of Mathematics, Allegheny College*, and Donald H. Ballou, Ph.D., *Assistant Professor of Mathematics, Middlebury College*. Cloth. Pages vii+206+9. 14×22.5 cm. 1943. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $2.40.

ORGANIC CHEMISTRY, by C. W. Porter and T. D. Stewart, *Members of the Faculty of the College of Chemistry in the University of California*. Cloth. Pages v+577. 14.5×22 cm. 1943. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $4.00.

SCIENCE AND THE FUTURE, ESSAYS OF THE WINNERS OF THE WESTINGHOUSE SCIENCE SCHOLARSHIPS IN THE SECOND ANNUAL SCIENCE TALENT

SEARCH. Paper. Pages vi+128. 11×18 cm. 1943. Science Clubs of America, 1719 N Street, N.W., Washington 6, D. C.

TEACHER'S KIT OF AVIATION MATERIALS FOR JUNIOR AND SENIOR HIGH SCHOOL consisting of forty folders. Unit I—Parts of the Fuselage, twelve large scale prints, United Air Lines Map of the United States, and two booklets as follows: Aviation Manual, edited by William A. Wheatley, *Director of School and College Service* and Ray O. Mertes, *Assistant Director.* 50 pages. The Airplane in the Scheme of Post-War Transportation, by W. A. Patterson, President, United Air Lines. 15 pages. United Air Lines, Room 305 Palmer House, Chicago, Ill.

ANNUAL REPORT 1942, General Education Board founded by John D. Rockefeller in 1902. Paper. Pages ix+120. 14×22 cm. General Education Board, 49 West 49th Street, New York, N. Y.

BOOK REVIEWS

MAP INTERPRETATION WITH MILITARY APPLICATIONS, by William C. Putman, *Department of Geology, University of California at Los Angeles.* Cloth. Pages viii+67. 21×28 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.25.

"The purpose of this book is to provide a background for understanding the significance of the landscape, as it is represented on maps." This quotation from the Preface states definitely the character of the text. It is to provide students especially those in the armed forces, with an introductory course in map study. It gives the student the main facts about contour maps and aerial photographs. It describes geologic formations on the surface and the effects of the erosive processes produced by streams, winds, waves, glaciation, and coast waters. The chief preparation by students is a study of topographic maps and charts. A page of well selected references is divided into three section, (I) Geology Texts, (II) Military Applications of Geology, and (III) Map Reading and Interpretation of Aerial Photographs. The text is well illustrated with excellent photographs, maps, and drawings.

G. W. W.

ELECTRONIC PHYSICS, by L. Grant Hector, *National Union Radio Corporation;* Herbert S. Lein, *University of Buffalo;* and Clifford E. Scouten, *University of Buffalo.* Cloth. Pages viii+355. 14×21 cm. 1943. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $3.75.

This is in no sense the usual text with this title. It is strictly a text for the beginning student of physics. Approximately the first half of the book gives the fundamentals of electricity but the discussion is often so brief that facts are given without explanation. The first nine chapters cover the fundamentals of direct current electricity. Chapter 10 and 11 give the fundamentals of inductance, alternating current, and condensers. Chapter 12 and 13 briefly discuss radio and electron tubes. Chapter 14 consists of a few pages on X-rays. Chapters 15 to 19 give the fundamentals of geometrical optics and chapter 20 is made up of six pages on infra-red and ultraviolet radiation. Interesting brief chapters on photoelectricity, electric waves, natural radioactivity, and transmutation complete the discussion. Each chapter is introduced by a very short overview consisting of a few sentences. At the end of each chapter there is a list of the principal ideas developed; a sentence giving the central thought of the chapter; two lists

of problems, one elementary and the other more advanced; and finally some suggestions for experimental work. A very attractive feature of the book is the use of two colors in practically all the drawings. The authors state that the book has been used with regular college students, special classes for ground school pilots and signal corps radio men, and a few high school students. There is, however, nothing that the ordinary high school student should not be able to master and it is a very limited preparation for any college group of technical men.

G. W. W.

MATHEMATICS ESSENTIAL TO ELECTRICITY AND RADIO including principles of direct-current and alternating-current circuits, by Nelson M. Cooke, *Lieutenant, United States Navy; Member, Institute of Radio Engineers* and Joseph B. Orleans, *Head of Department of Mathematics, George Washington High School, New York City.* Cloth. 16×23 cm. Pages x+418. McGraw-Hill Book Company, Inc., New York. 1943. Price $2.40.

As the title indicates, this text is designed to meet a need in a specialized field. One would probably not want to use such a book in a general course in mathematics. Topics covered include algebra through quadratics, logarithms, plane trigonometry, and elementary vector analysis. At the same time the mathematical development is accompanied by such topics as electrical units, Ohm's law, resistance, application of logarithms to decibels and transmission lines, Kirchhoff's laws, alternating currents.

There are approximately 2500 problems, with answers to all problems bound in the back. Mathematical tables include four place common logarithms and natural values of the sine, cosine, and tangent. The preface states that the authors have attempted to adapt Lieutenant Cooke's book on *Mathematics for Electricians and Radiomen* (upon which the Navy has based a refresher course) to the secondary school level. Whether or not the text is suitable for a special course, it certainly provides an unusual amount of supplementary material showing applications of mathematics in one field. If for no other reason, the discussion of the use of complex number notation in series circuits found in article 29-11 would warrant the purchase of the text as an answer to the question often asked by students, "Are imaginary numbers ever used for any practical purpose?"

CECIL B. READ
University of Wichita

MATHEMATICS OF FLIGHT, by James Naidich, *Chairman, Department of Mathematics, Manhattan High School of Aviation Trades, New York City.* Cloth. 16×23 cm. Pages x+409. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 18, N. Y. 1943. Price $2.20.

This is another of the large number of secondary school texts in mathematics which have recently appeared, each designed to provide the mathematics essential to a specialized field. Where the school system is such that there is a class with such common interest such texts would seem to be ideal; if the interests of the class are varied it is doubtful if one would wish to select such a book as the class text, although texts in varied fields should be available for reference and supplementary material.

The mathematics covered goes as far as elementary trigonometry. Part One, comprising one-half of the text, is entitled a review of mathematics of aviation, and covers selected topics in algebra, geometry, and trigonometry, with problem emphasis upon aviation. Part II is a chapter of about 35 pages devoted to center of gravity, stability and control; Part III is a discussion of elementary aerodynamics (approximately 130 pages); Part

IV is entitled "Aircraft Research and Specifications" and includes data relative to performance and specifications of 27 selected modern airplanes (one wonders how long this information will remain accurate). An appendix covers such topics as extraction of square root, use of tables of squares and square roots, and includes brief tables of weights and measures, also a table of sines, cosines, and tangents. In general the supply of problems seems ample, although in a few places one might wish additional exercises; answers are not provided in the text. Illustrative examples are provided at frequent intervals.

CECIL B. READ

NAVIGATIONAL TRIGONOMETRY, by Paul R. Rider, *Professor of Mathematics, Washington University*, and Charles A. Hutchinson, *Professor of Engineering Mathematics, University of Colorado*. Cloth. 14.5×22 cm Pages ix+232. The Macmillan Company, New York. 1943. Price $2.00.

With the growing demand in the present emergency for the use of methods of spherical trigonometry in the fields of air and marine navigation, there have appeared many books on spherical trigonometry, ranging from a reprint of a chapter in a text on trigonometry to rather extensive discussions. The text under consideration devotes more space to the problems of navigation than a number of other texts. The text proper, excluding tables, covers 140 pages, of which 70 are devoted to applications and problems of navigation, as evidenced by these chapter headings: The Terrestial Sphere, Charts, The Sailings, Astronomical Triangle, Lines of position.

Features which seem to be of special merit are: a clear statement of standards of accuracy in calculation (in general, data are given to tenths of a minute for use with five place tables); a consistent following of the standards of accuracy statements in the answers given; the treatment of the haversine solutions, with good five place tables provided; a neat and precise form of computation; a definite attempt to make the data authentic; a large number of well selected exercises, with answers to the odd numbered problems.

There are few details to which one might raise objection. In a few cases the number of exercises relating to a particular topic seems insufficient. In the discussion of the mil no mention is made of the fact that the air corps uses a mil with a slightly different definition. In the discussion of lines of position by use of tables no mention is made of the use of tables which, while at present confidential, are reported to shorten the work even more than H.O. 211 or H.O. 214. These items are relatively trivial; one desiring a text for spherical trigonometry in which navigation is to be considered can not afford to omit consideration of this book. One peculiar omission is noted, that of a table of logarithms of numbers.

CECIL B. READ

PLANE AND SPHERICAL TRIGONOMETRY, ALTERNATE EDITION, by Lyman M. Kells, Ph.D., *Professor of Mathematics*, Willis F. Kern, *Associate Professor of Mathematics*, and James R. Bland, *Associate Professor of Mathematics, All at the United States Naval Academy*. Cloth. 16×23 cm. Pages xvii+400 (without tables). McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. 1943. Price $2.00.

To one who has used the spherical portion of the text, the appearance of an alternate edition met with approval, in the hope that some of the criticisms of the earlier text might be done away with. From the point of view of the objectional features in the reviewer's own courses, none have been

removed—in other words the book still must be presented to the student with excuses, even less excusable in a second edition. For example: the original edition had many errors in answers, frequently only a few seconds in an angle, but annoying to the student. After checking twenty such problems, and finding no corrections had been made, one seems justified in assuming no attempt was made to correct. In illustrative example 1 on page 228 the given problem is not solved—a repetition of an error in the first edition. In various places the alternate edition has a better statement or definition than the first edition; however there are still doubtful places; is a four place table one with mantissas tabulated to 4 significant figures, or to four decimal places? The treatment of accuracy of computation is ignored both in the previous and in this edition. Apparently one may obtain results correct to the second of arc, irrespective of whether given data were correct to the nearest degree or nearest second. One might look at problem 19 on page 83, which asked for an approximate answer, one datum given being a man six feet tall—the answer is given to hundredths of a foot (if this is an approximate answer, what accuracy is needed for an answer not considered approximate?) On page 236 in problem 31 the "hint" suggests the use of the nautical mile; the answer is obtained by the use of the statute mile. This last example, repeated from the previous edition, has confused many a student. In the alternate edition, as has been indicated, many of the problems, in fact a very large part of them, are identical with those in the previous edition.

In spite of the items mentioned, which may be in part the personal prejudice of the reviewer, the book has definite merit. The applications are such as to attract the interest of the student; in particular the discussion of navigation is more complete than in many texts. Illustrations are well chosen, the alternate edition having many improved illustrations. The form for solution of logarithmic problems is unusually well arranged and compact. It may be mentioned, however, that in some places the illustrative solutions make use of logarithms of secants and cosecants. This results in a saving of labor, but also requires that such tables be available, as they are in the tables which are bound with the text if so desired. The text includes a chapter on the slide rule, a discussion of the range finder, the use of the mil as an angular unit (in common with most texts, it ignores the fact that the definition of a mil is not the same in all branches of the armed forces).

CECIL B. READ

SOLID GEOMETRY AND SPHERICAL TRIGONOMETRY by Henry L. C. Leighton, A.B., A.M. *Instructor in Mathematics, The Phillips Exeter Academy.* Cloth. 16×23 cm. Pages xix+210. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. 1943. Price $2.20.

This text is rather definitely of the traditional type, emphasizing proofs of theorems, rather than giving a minimum of proof with emphasis upon mensuration. Nevertheless, there are many practical problems applying the principles. There are more than 750 exercises; many of these have several parts. No answers are printed, nor are there any tables. Data in the section on trigonometry are given to minutes, and the illustrative examples use four place logarithms. There is a chapter on applications of spherical trigonometry, including use of the cosine-haversine formula in great circle sailing, and a brief discussion of the celestial triangle. Throughout the text one finds occasional reference to material which a student may encounter in more advanced work. There were no misprints noted.

CECIL B. READ

GEOGRAPHY IN HUMAN DESTINY, by Roderick Peattie, Ph.D., *Professor of Geography, Ohio State University*. Cloth. 323 pages. 14×21 cm. 1940. George W. Stewart, New York, N. Y. Price $3.00.

This volume is a humanistic historical geography written for the non-professional reader, rather than the trained scientist. It correlates the two subjects and points out the reasons why Europe seems always at war. The author's clear simple style makes it easy reading and his personal experiences are both fascinating and refreshing.

The first two chapters are concerned with a definition of geography, and contrasting philosophic viewpoints. They contain a quantity of old, well-known geographic material, but the statements are vividly presented as fact relationships, rather than mere facts. "Geography is a correlation of sciences" and the subject "must be looked upon not as an old-fashioned matter of national boundaries and the location of capital cities, but as a living subject, full of a variety of human life, which explains the way of living in all their myriad diversity."

The central portion of the volume shows the relation of the environmental factor to evolution and regional psychology. These chapters are definitely a defense of environmentalism and the influence of Ellen Churchhill Semple is very evident. Not everyone will agree with the philosophy of the author, but Professor Peattie would never expect an agreement of opinion, for new ideas are born only by diversity of thought and independent thinking. Certainly his discussion of provincialism will carry the reader beyond the realm of twentieth century reality, and into a story of historical culture as preserved by geographic isolation.

The last portion of the book brings us into the era of modern geography: economic regions, national competition, European conflicts, conservation and socialism, and finally the geography of peace. The treatment of physical geography and the *first* World War is clear, simple and concise. These controversial subjects are handled with a technique that is indicative of Professor Peattie's broad training in the social sciences and humanities. Few geographers have read and travelled as widely as the author and he is able to present a breadth of view that is a rarity among writers.

The volume covers a period "From Stone Axe to Dive Bomber," but it is not an account of kings and wars. It is a geographic interpretation of the story of man through the ages and comes from the pen of an individual trained both as a scientist and as a social philosopher. The book is absorbing enough to be read by the professor, the business man, or the housewife with equal interest and admiration. Once started it will not be laid aside unfinished.

ALDEN CUTSHALL
University of Illinois

ELEMENTARY STATISTICAL METHODS, by Helen M. Walker, *Professor of Education, Teachers College, Columbia University*. Cloth. Pages xxv+368. 15×23.5 cm. 1943. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $2.75.

The author has done an excellent piece of work in meeting the following standards which she has set for this text: (1) Complete clarity for the beginner and such simplicity of exposition as will make the text practically self teaching. (2) More than ordinary attention to the development of underlying concepts and to interpretation. (3) Such harmony with recent developments in the mathematical theory of statistics as will insure a satisfactory foundation for more advanced study. (4) The presentation of a fundamental core of introductory material which can be covered by an

average class in one semester. (5) The inclusion of other material to serve as reference and as invitation to further study.

In Chapter I the author introduces certain special features, a knowledge of which is important to the student. These include the nature of statistical thinking, statistical method and statistical theory, descriptive statistics and statistical reference, character of presentation in the text, reading habits, and misuses of statistics.

The exercises in the text serve two purposes. First are found the usual type of practice exercises which apply the material presented. The second type of exercise is designed to clarify meanings, to encourage the student in an active search for relationships, and to stimulate his abstract imagination in respect to statistical ideas.

The material is well presented. The symbols, formulae, tables and diagrams are not crowded and should not prove alarming to the non-mathematical student. At the end of the book will be found an excellent glossary of symbols used in this text and in other texts. The book should be well received by both teachers and students.

CHARLES A. STONE

WARTIME REFRESHER IN FUNDAMENTAL MATHEMATICS, by Lieut. W. C. Eddy, U.S.N. (Ret.), A. H. Brolly, *Chief Instructor*, Ensign E. S. Pulliam U.S.N.R., E. C. Upton, and G. W. Thomas, *U. S. Naval Training School, Chicago*. Cloth. viii+248. 2×13×19 cm. 1942. Prentice-Hall, Inc., New York. Price $1.50.

This book provides practice in the application of mathematics and presents all working formulas in such language that the inexperienced may grasp with a minimum of difficulty. It is written for the person who can take advantage of the expressions as a layman would present them.

The problems are keyed to today's technical needs and are as practical as opportunity permits. The subject matter is arranged for five days in the week for a period of four weeks, thus covering twenty titles. The individual chapters have been arranged to move from simple arithmetic to complex algebra.

JOSEPH J. URBANCEK
Lane Technical High School

ELEMENTARY MATHEMATICS FOR THE MACHINE TRADES, by John J. Weir, B.S., M.A., *Instructor, Sperry Gyroscope Co.; Former Instructor, Mechanical Drawing, William L. Dickinson High School, Jersey City, N. J.* Cloth. viii+194. 1.5×14×21 cm. 1943. McGraw-Hill Book Co., Inc., New York. Price $1.60.

This text presents the essential mathematics of the machine shop. It is of sufficient scope so that not only the beginner may profit from its contents but the experienced machinist may gain new information to fortify him for new types of work. Wherever possible mathematical theory and shop practice have been combined with emphasis on the practical side.

JOSEPH J. URBANCEK

MATHEMATICS FOR PILOTS. Published under the Supervision of the Training Division, Bureau of Aeronautics, U. S. Navy. Cloth x+158. 1.4×12×19.5 cm. 1943. McGraw-Hill Book Co., Inc., New York. Price $0.75.

This book is one of a number on various related subjects of the Flight Preparation Training Series put out by the same publishing company. It covers those fundamentals of mathematics which the pilot must know to

be able to solve navigation problems quickly and accurately and to understand the few simple formulas used in the discussions on the principles of flying.

Where possible and convenient the problems are made to apply to some practical situations. The major emphasis falls on fundamental operations, conversion factors, fractions, percentage, powers and roots, angular measurement, vectors, equations, variation, graphs, and some selected geometry and trigonometry.

JOSEPH J. URBANCEK

PHYSICS MANUAL FOR PILOTS. Published under the Supervision of the Training Division, Bureau of Aeronautics, U. S. Navy. Cloth. x+230. 1.6×12×19.5 cm. 1943. McGraw-Hill Book Co., Inc., New York. Price $0.90.

This book is one of a number on various related subjects of the Flight Preparation Training Series put out by the same publishing company. It covers material essential as fundamental knowledge for pilots.

In order that pilots may have the advantage of basic principles emphasis is placed on such topics as: forms of matter, types of units, fluids at rest, fluids in motion, heat, atmospheric humidity, balanced forces and torques, work, power, horsepower, friction, properties of materials, uniformly accelerated motion, motion and forces, energy, uniform circular motion, gyroscopes, magnetism, electricity, sound, and light.

JOSEPH J. URBANCEK

A TREASURY OF SCIENCE, edited by Harlow Shapley, *Director of the Harvard College Observatory;* Samuel Rapport, *a member of the staff of Harper and Brothers;* and Helen Wright, *formerly of Vassar Astronomy Department.* Cloth. Pages xi+716. 14.5×21.5 cm. 1943. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $3.95.

Here is a science book for every one. Selections from the greatest science writings of all times tell the reader of Science and the Scientist, The Physical World, The World of Life, and The World of Man. Those who prepared the book are among the best writers of our time. They made a long and careful study of hundreds of articles and books and selected the best. The result is truly a science treasury, the best that has been written by more than sixty of the world's great scientists and writers of science. It is a book that possibly few will read consecutively from beginning to end. Each one will read an article wherever he happens to open the book. It is all interesting and much of it will be new to all readers. All the great branches of science are visited in a new and interesting manner. *The Orderly Universe* by Forest Roy Moulton and *The Milky Way and Beyond* by Sir Arthur Eddington tell us of the heavens. *Geological Change* by Sir Archibald Geike and *Man, Maker of Wilderness* by Paul B. Sears give us vivid pictures of changes on the earth. *The Discovery of Radium* by Eve Curie and *The Forming of Energy* by George Russell Harrison give us brief but lasting views of matter and energy.

Then comes Part Four: "The World of Life" with Paul de Kruif's *Leeuwenhoek: First of the Microbe Hunters,* William Beebe's *Secrets of the Ocean,* and Julian Huxley's *The Courtship of Animals.* Finally we read the wonderful sections on "The World of Man." Here the great writers Vilhjalmur Stefansson and Sir Arthur Keith entertain and instruct us. We learn of the conquest of disease by Edward Jenner and Victor Heiser. *Brain Storms and Brain Waves* by George W. Gray will interest and intrigue everyone. *Science and the Future* by David Dietz forms one of the intriguing sections of the last group entitled "Man's Future."

It is a wonderful book, entertaining, instructive, delightful. An excellent present for anyone.

G. W. W.

BASIC ELECTRICITY, by Wilbur L. Beauchamp and John C. Mayfield. Cloth. Pages viii+312. 19.5×28 cm. 1943. Scott, Foresman and Company, 623 S. Wabash Avenue, Chicago, Ill. Price $1.60.

This is one of the numerous books prepared to meet the demands of the War Department. Boys must learn the important principles of electricity and know how to apply them. All of this must be accomplished in a few weeks of study. Students having a wide range of abilities, interests, and previous experiences make up the classes which use the book. The plan of the book shows that the authors understand these difficulties and variations. They have produced a book for the beginner, the student who knows practically nothing about how electricity operates and how it is controlled. For such a student the big job is to prepare him rapidly in understanding, use and care of electric circuits and instruments. Starting with a dry cell, a small electric lamp and a single pole knife switch on the first page, the authors in twelve brief chapters guide the student to an understanding of the types of circuits he will use. By clear language, excellent drawings, directions for experimental work, and a minimum of mathematical processes and symbols, all of which are completely explained, the student is taught to handle the practical apparatus he will contact. He learns the fundamental electric circuits, how to make and use them; the important measuring instruments, their construction and use; the essentials of practical dynamos and how they operate. He learns the construction and use of a telegraph set, the electric circuits of an automobile, the important parts of a simple telephone circuit, a three-wire lighting circuit, and the fundamental circuits of radio. The plan of the book, its content—the things explained and the parts omitted, the clear language and well selected illustrations used, the excellent diagrams and the large photographs of practical electric apparatus all show that the authors know the difficulties of students and how to surmount them. The reviewer believes this book marks important progress in the right direction. Proper use of such a book in the hands of real teachers will do more for the boys preparing for war-time jobs both in the armed forces and on the home front than most of the engineering texts now available.

G. W. W.

FUNDAMENTALS OF ELECTRICITY, by Charles E. Dull, *Head of Science in West Side High School, Newark, New Jersey and Supervisor of Science in Newark's Junior and Senior High Schools;* and Michael N. Idelson, *Head of Science in the Abraham Lincoln High School of New York City.* Cloth. Pages xx+456. 13×18.5 cm. 1943. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $1.48.

This text was prepared at the request of the War Department for use in a course of the same name outlined in Pamphlet PIT 101. The authors have organized their material into fourteen chapters, the first thirteen of which follow the War Department outline, including section headings, exactly. The field covered is large for a one semester course, but this is necessary in order to meet the requirements set up by the War Department.

The book is amply illustrated with diagrams and half-tones, most of which are exceedingly clear. The outline method of presentation simplifies the study of the material. The text is comprehensive in that it includes

much information that must ordinarily be brought to the class by the teacher.

Interspersed throughout the descriptive sections are many demonstration experiments; instructions for preparing these are included. Perhaps teachers not sufficiently trained in physics will find some inadequacies in these directions. The teachers' manual, prepared by the authors, will probably clarify demonstration directions found in the text. When formulas are used in the descriptive material, each is illustrated with two or three problems.

The last chapter, devoted to radio and television, is perhaps of doubtful value. It is too brief to have more than popular appeal. However, it may serve to interest the student in the study of radio.

Each chapter is followed by a series of objective, self-testing exercises as well as a number of essay questions. The nineteen experiments at the end of the book place too much emphasis on magnetism and static electricity—seven of them being devoted to these topics.

Of value to both student and teacher is the appendix which includes mathematics and physics tables; a summary of the formulas found throughout the text, and a mathematics review.

F. L. BURLINGAME
Tuley High School, Chicago

PRE-SERVICE COURSE IN ELECTRICITY, by William C. Shea, *Instructor in Applied Science and Coordinator of Defense Activities and High School Subjects, Straubenmuller Textile High School, New York City.* Cloth. Pages vi+276. 13.5×21.5 cm. 1943. John Willey and Sons, Inc., 440 Fourth Avenue, New York, New York. Price $1.52.

The material included in this text covers the pre-induction training course in fundamentals of electricity outlined in War Department Pamphlet PIT 101. The author has made a definite attempt to simplify the presentation for students with limited backgrounds in science and mathematics. Theoretical discussion is subordinated to clear explanation of facts. Equations, when used, are presented in words rather than symbols. A restatement in sentence form follows each word equation. The fundamentals are clearly expressed. Simple analogies to common-place phenomena help to clarify difficult scientific topics.

The form of the book is good; the print is large; chapter headings and sub-headings stand out clearly in bold face type. The problems in the text would perhaps be more distinct if all instead of only some of them were set off in a different size type.

Each of the thirteen chapters contains several essay questions and sufficient problems. The book is amply illustrated as to number of drawings although a few are either too small or too complicated.

The lack of directions for demonstration and class experiments will perhaps make the text a difficult one for teachers not well versed in physics.

Considering the varied background and ability of the students for whom the book was designed, the author has succeeded in fulfilling the purpose outlined in his preface.

F. L. BURLINGAME

CHEMICAL SOLUTIONS, by Frank Welcher, *Assistant Professor of Chemistry, Indiana University.* Cloth. Pages vii+404. 15×23 cm. 1942. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Price $4.75.

This book is a compilation of brief directions for the preparation of solutions of standard acids and bases, indicators, salts, special tests reagents,

bacteriological culture media and stains, etc. Trade formulas, such as those used in photography, metal plating baths, cleaning agents, etc., are not included. Alphabetical entries, listed according to the major constituent of the solution or the name of the discoverer, include the use of each solution, the procedure for its use whenever practicable, a list of substances which interfere in making special tests, and a statement regarding the stability and sensitivity of the solutions. In each case, a reference to one of 36 standard reference books or 98 periodicals is included. The references are not intended to be historical or exhaustive, but to represent the most convenient source of further information, preferably in the English language.

Although no claim is made for completeness, solutions commonly used in analytical chemistry, organic chemistry, biochemistry, bacteriology, metallurgy and metallography, etc., are listed as well as the solutions used in college and high school instruction. An index of the reagents, arranged according to their uses, is included. A difficulty in using the book would appear to be choice of the best reagent since, for example, 45 test reagents for albumin, 35 for glucose, and 60 for alkaloids are listed. A critical evaluation of the various test solutions, however, would lie far beyond the scope of a book as comprehensive as this one.

The volume shows evidence of careful preparation and editing, both by the author and publisher. Frequent cross-indexing references appear and no important omissions were noted. Paper, binding, and type are of excellent quality.

High school and college laboratories, particularly those lacking complete periodical libraries, should find this book of great value. Research, control and test laboratories will find it a convenient and time saving reference volume.

H. A. LAITINEN
University of Illinois

THE OCEANS, by H. U. Sverdrup, *Professor of Oceanography, University of California, Director Scripps Institution of Oceanography;* Martin W. Johnson, *Assistant Professor of Marine Biology, University of California, Scripps Institution of Oceanography;* and Richard H. Fleming, *Assistant Professor of Oceanography, University of California, Scripps Institution of Oceanography.* Cloth. Pages x+1087. 15×23 cm. 1942. Price $10.00. Text Edition $8.00.

It is a far cry from the forgotten and out dated Physical Geography of the Sea by Matthew F. Maury, an American geographer who made the first international oceanic charts, to the above scientific and comprehensive oceanography.

This complete survey of the established knowledge of marine science indicates the great progress in oceanography since Maury's time. The authors are director and active investigators of the Scripps Institution of Oceanography of California which has been a great center for the advancement in oceanic knowledge in the past two decades.

This treatise is really comprehensive. The chemical and physical properties of ocean waters are completely presented, the biological aspects of the sea populations are fully discussed, the difficult mathematical explanations of ocean waves, tides and currents are simple and clear, marine sedimentation is given a modern interpretation and there is a full explanation of the plant and animal life in ocean waters.

This book of some 1000 pages is the best English summary of the science of oceanography. It is a must for any scientific library or any large collection of modern scientific books.

VILLA B. SMITH

A CORRECTION

Due to an oversight, the names of the members constituting the Chicago local membership committee were omitted from the roster of local committees in the 1943 yearbook. This very active committee consisted of the following members:

Helen Lowes, Chairman; William H. Taft High School
Mrs. F. K. Ballard, George Williams College
Jeanette Fox, William H. Taft High School
Thelma Jones, Bowen High School
L. T. Lucas, Lake View High School
Bernice von Horn, Branch, Hyde Park High School
J. P. Esposito, Crane Technical High School

J. E. Potzger, Editor 1943 Yearbook

CLIFFORD B. UPTON, CHAIRMAN OF THE BOARD AMERICAN BOOK COMPANY

Professor Clifford B. Upton, for many years Professor of Mathematics, Teachers College, Columbia University, was elected Chairman of the Board of Directors of American Book Company at its last meeting, effective November 1, 1943. He has been a member of the Board for many years, and has always taken an active part in the affairs of the company.

Mr. Upton succeeds Mr. A. Victor Barnes who had asked the Board to accept his resignation as Chairman in view of his advancing years. Mr. Barnes has been associated with the American Book Company for nearly fifty years in various official capacities, has been a member of the Board, and has served as its Chairman. With the Company in such excellent condition and its affairs so well in hand, Mr. Barnes felt he would like to have more time to devote to his personal interests. He will remain on the Board as a Director, and will continue to give the Company the benefit of his long experience.

Professor Clifford B. Upton brings to his new association qualifications and experience which assure a contribution of importance to the business of publishing school and college textbooks. His broad training and extensive knowledge of the problems of education, his years of experience in the training of teachers, and his extended acquaintance among school people everywhere, give Mr. Upton especial equipment for his new duties. Moreover, he has had unusual opportunity to put his abilities to practical use in the preparation and publication of many successful books of his own authorship. The American Book Company is to be congratulated on its success in meeting this important situation.

LARGEST BUTADIENE PLANT IN WORLD SOON TO BOOST U. S. RUBBER OUTPUT

Enough butadiene to produce one-seventh of the entire wartime requirement of synthetic rubber soon will be turned out in a single plant operated without profit by the oil industry, Herbert Henderson, chairman of the board of the Neches Butane Products Company, announced here. The first of two units, now almost completed at Port Neches, Texas, will be placed in operation in mid-December and the second will be ready shortly thereafter, he said.

Through a radically new process, developed by oil industry engineers, the amount of butadiene to be manufactured from a barrel of oil will be more than doubled and the refinery gases remaining after the butadiene has

been manufactured can be used in production of high octane gasoline and other products, he said. This process, proved in a laboratory model, has been turned over to the Government and has already been found practicable in smaller plants.

The Port Neches plant, which will be the world's largest producer of butadiene, principal ingredient of synthetic rubber, is being financed by the Defense Plant Corporation. It will be operated by the Neches Butane Products Company, organized by five oil companies with refineries in the region to bring to the synthetic rubber program the combined experience, "know how," and patents of the entire petroleum industry.

None of the companies, Mr. Henderson pointed out, will receive any profit or management fee of any kind. In fact, he added, they are contributing the services of management and technical personnel assigned to the project and are even paying their expenses.

Refinery gases, produced in the manufacture of petroleum products, will be piped to the butadiene plant from nearby refineries of the five participating companies—The Atlantic Refining Company, Gulf Oil Corporation, The Pure Oil Company, Socony-Vacuum Oil Company and The Texas Company. After the production of the butadiene, the remaining gases will be returned to the refineries for the production of high octane aviation gasoline and other products. The gases, or raw stock, will be supplied to the Government on a cost-of-production basis.

Mr. Henderson described the project as "another victory for the Allies" because of its importance to the rubber program.

"When the oil industry was called upon to help solve the rubber problem shortly after Pearl Harbor, butadiene had never been produced in large quantities," he continued. "There was no known way to make it from petroleum and at the same time conserve our oil supply for such vital uses as high octane gasoline, motor fuel, lubricants and other products. Petroleum engineers developed a process, built a laboratory model, and found it would work. Then we went ahead with the building of the plant. Nothing like it had ever been built before so we had no actual experience to guide us."

The plant will have a capacity of 100,000 tons of butadiene a year, sufficient to produce more than 110,000 tons of synthetic rubber for the Government's Rubber Reserve Company. The nation's synthetic rubber goal is 800,000 tons.

The entire rubber project at Port Neches, which consists of the butadiene plant and two copolymerization units in which the synthetic rubber is made, is Government owned, although it was designed, built and will be operated by private industry.

There is nothing so strong or safe in any emergency of life as the simple truth.—DICKENS.

The first record of the Azores on a map was in 1351. From 1580 to 1640 they, like the rest of the Portuguese kingdom, were subject to Spain. It was during these years that they served as a great rendezvous for fleets on their homeward voyages from the Indies and became the center of notable marine warfare carried on by the British under Queen Elizabeth against the Peninsula powers.